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Improved Universal Grinding Machine.

On this and the next page we give illustrations of an improved universal grinding machine, which, in its original form, has accomplished much in the way of modifying machine shop practice, by demonstrating not only the superiority, but also in many cases the economy of grinding cylindrical and conical surfaces to size and finish, instead of finishing them by the older methods.

The present form of the machine, embodying, as it does, some notable departures from the original design, is the result of experience of the builders and others in its use, and of a thorough study of the requirements for such work as it is expected to do.

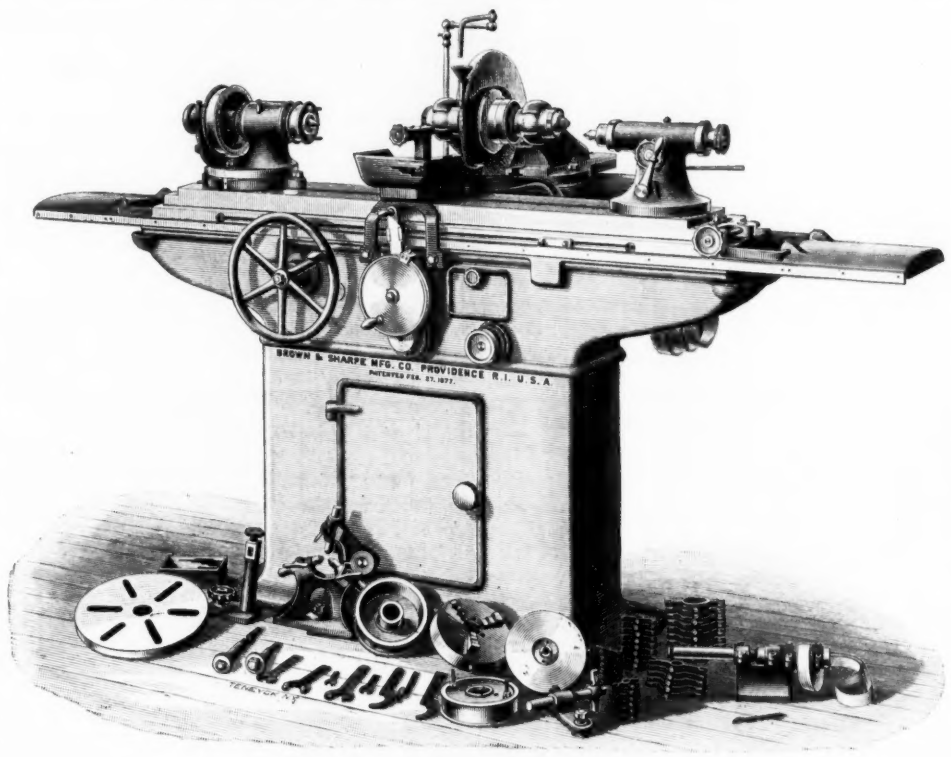
The most notable difference, perhaps, between this and the original machine is in the form of the bed, which, as shown by the rear view, extends straight down to the floor from the wheel base, instead of having the latter supported upon brackets projecting from the back of the machine. This, of course, adds greatly to the solidity of the machine, and all danger of springing of the bed is avoided by its massive construction, with internal system of bracing, and the further fact that it rests upon the floor on three points, one at each end in front, and the third at the back under the wheel base. In addition to this, the entire machine is made very much heavier in all its principal parts, the sliding platen, with the swivel table, head and foot-stocks, for instance, weighing 225 pounds more than the corresponding parts of the former machine, while the weight of the wheel slide, with its table and stand, is more than three times as heavy as formerly.

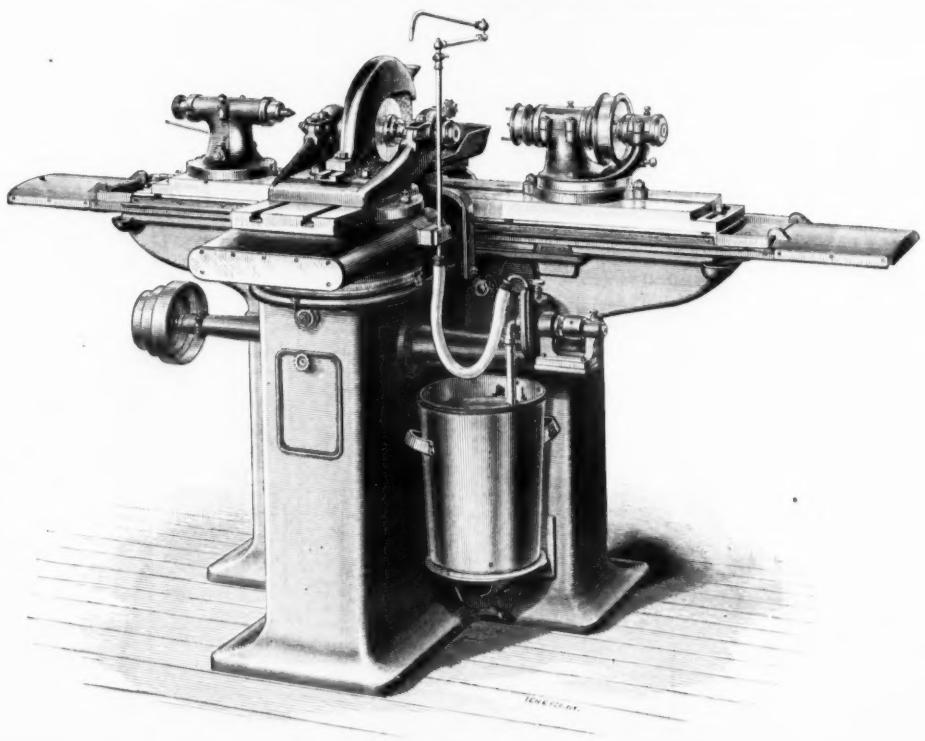
Upon the bed, which is fitted as a closet, with shelves each side of the door, the platen moves, one of the slides being V-shaped, while the other is flat, the total bearing being twice as great as in the former machine, and provision being made for automatic lubrication by means of rolls in each slide. Outside of the pockets formed at each end of the platen are shields, or dust caps, which protect the slides from dust when the platen is moved to its extreme distance in either direction, and these are so shaped as to make it very inconvenient to place heavy weights or parts of machines on them, as this has been found to interfere with the doing of accurate work.

The swivel table upon which the head and foot-stocks are placed is pivoted at the center as usual, and at its right-hand end is provided with a double system of graduations by which angles may be read either in degrees or in taper to the foot; the scale marked "Taper in inches per foot" giving the whole taper of the work, while that marked "Degrees" gives the angle from the center line of the work, or one-half the whole angle. By this arrangement, together with the adjusting screw provided, very accurate settings can be obtained, and for all ordinary work the table is found to be sufficiently heavy, so that clamping is unnecessary, though clamping screws are provided at each end for use when doing heavy work.

A T-slot is provided in this table for attaching the head and foot-stocks, which is scraped to a straight edge, and the tongues of the head and foot-stocks scraped to fit it. They may, of course, be fastened at any point on the table, the former by two bolts, and the latter by a lever and eccentric clamping device.

Figs. 25 and 26 (page 2) give views of the head-stock with the spindle and its boxes in longitudinal and cross-section. As will be seen, the base turns upon a central pin, and is graduated in degrees so that it may be placed at any angle. The front upright is made exceptionally heavy, to resist the tendency to vibration, and the journal is large. The spindle is of crucible steel, with both bearings hardened, ground and lapped. It is hollow, as is also the foot-stock spindle, to facilitate removal of centers, besides which its extension beyond the dust-cap at the rear enables a bolt to be passed through and used to secure work to the face-plate when desired. Two different sized whirls are provided for use in dead-center grinding, and there is a stop which engages the pulley as shown, and prevents the spindle turning during such grinding.





IMPROVED UNIVERSAL GRINDING MACHINE.

Phosphor bronze has been chosen as the material for the boxes, as it permits of their being quite tight on the spindle when face plate or internal work is being ground, and this is found to be important where the greatest accuracy is required. End thrust is taken entirely by the forward bearing, and lost motion is conveniently taken up by means of check nuts with fine threads. As will be noticed, the thread on the spindle is not cut clear up to the shoulder, but back of the thread is a bearing left for chucks or other fixtures, so that they may be made to run true. This bearing, and also the taper hole in spindle, are ground out after the spindle is in place. The foot-stock spindle is quickly operated by a lever, and is pressed forward to the work by a stiff spring which allows it to adjust itself to any expansion of the work which may be caused by heating, and maintain a uniform pressure. The spindle is also provided with a hand-wheel and screw movement similar to that used on lathes, and by clamping the lever this hand-wheel may be used instead, as is desirable for heavy work. The movement of the spindle, as well as the pressure exerted by the spring, can be regulated by this hand-wheel.

The wheel bed may be turned so that the wheel is moved by the cross-feed hand-wheel at any desired angle with the sliding platen, and its base is graduated to degrees. The wheel slide moves on wide, flat bearings, eight times as large as those in the former machine, and things are so arranged that all sliding surfaces are thoroughly protected from dust. The circular base upon which the wheel slide is supported is greater in diameter than the distance between the bearings of the wheel spindle, so that a steady support for the latter is obtained.

Provision is made for internal grinding, and for this the wheel platen is turned around, and the wheel stand is used as a countershaft, two pulleys being placed upon the spindle in place of the single pulley and emery wheel used for outside grinding, while the internal grinding spindle with its supporting head is placed on the opposite end of the wheel platen. A sectional view, showing the construction of the internal grinding spindle, with its supports, is given at Fig. 40.

At Fig. 27 is a sectional view through the center of the main wheel spindle. This spindle is also of steel, hardened and ground, while the boxes are of phosphor bronze. As will be seen by reference to the cut, these boxes are tapering outside, and are fitted to sleeves, which, at the center of their length, have ball joints formed upon them, and rest in seats provided in the uprights, to which they are clamped by the caps *F F*, which are hinged and held down by bolts and nuts *E*, Fig. 28. By this arrangement, self-aligning boxes are secured, and the entire arrangement may be removed or replaced, or turned end for end, with the greatest facility, and without disturbing the adjustment of the boxes.

H H are pieces of felt for lubrication, held up against the spindle by springs; *C D* are the nuts by which the boxes are adjusted to the spindle, and end motion is taken up by the nut *A*. The boxes are 4½″ long and 1¼″ diameter. The pulley on the spindle is 4½″ diameter. As shown, it is held in place by the nut *J*, and can be removed, together with the wheel, by turning the flange *K*, which is threaded to the spindle. Provision is made for running a wheel outside the bearings, as shown, and this may be such a wheel as is shown in Fig. 36, where grind-

ing is to be done close up to a shoulder or collar. Of course this wheel may be brought to either side of the wheel support by reversing the spindle and boxes, or turning them end for end, as already explained.

Wheels of any desired form or size may be used here for grinding cutters or reamers, or for any special jobs not conveniently done by the regular wheel which runs between the bearings. Both wheels are protected by heavy gaurds, which not only prevent water or dust from flying about the machine or room, but also protect the workmen in case of the accidental breakage of a wheel while running.

Provision is made for the liberal use of soda water in grinding, channels being arranged so that, after being used, it is returned to the tank seen at the rear of the machine, from whence it is pumped to the wheel or work again by the centrifugal pump, which is driven by a belt from the countershaft.

The platen is, of course, movable either by hand or by the automatic feed arrangement, the latter being positive, so that it cannot become accidentally disengaged. The reverse motion of the platen is accomplished, as formerly, by the use of movable dogs, which can be clamped at any desired point at the front of the platen, and which actuate a small lever which stands up in front at the center of the machine, and which can be moved by hand when desired. And just here is one of the new features which will be appreciated by those who have had experience with the machine. A device has been introduced which allows the point of reversal to be shifted a very small amount by simply turning a screw, and without the necessity for moving the dogs. In addition to this, the attachment to the lever can be swung out of the way, so that the platen may be run past it for the examination or gauging of work when desired, without moving the dogs, and, when swung into place again, the platen reverses precisely as before. The feed and reversing mechanism has been much simplified, and reversal takes place smoothly, and without jar or vibration.

The cross-feed by which the wheel is brought up to the work is operated by a graduated hand-wheel; the graduations reading to .0005″, or corresponding to a reduction in diameter of the work of .001″. On the rim of this wheel a stop-screw is provided, by which the emery wheel can be given a movement so small as to reduce the diameter of the work only .0001″.

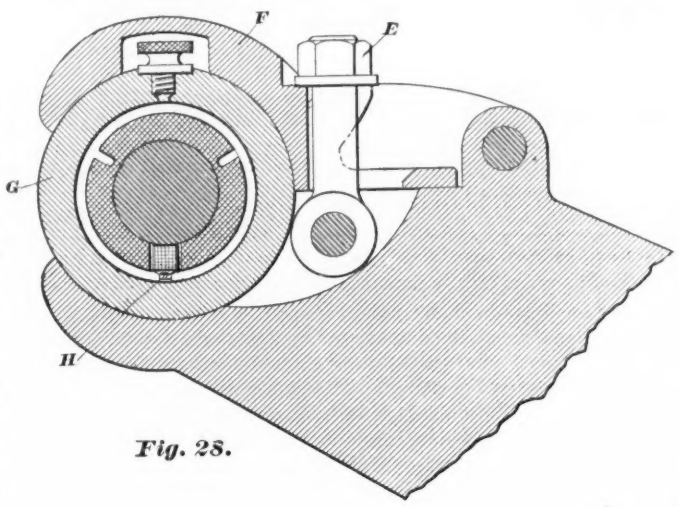


Fig. 28.

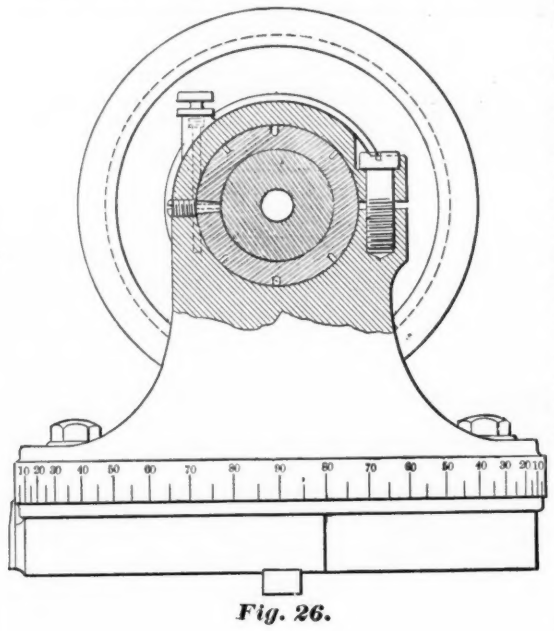


Fig. 26.

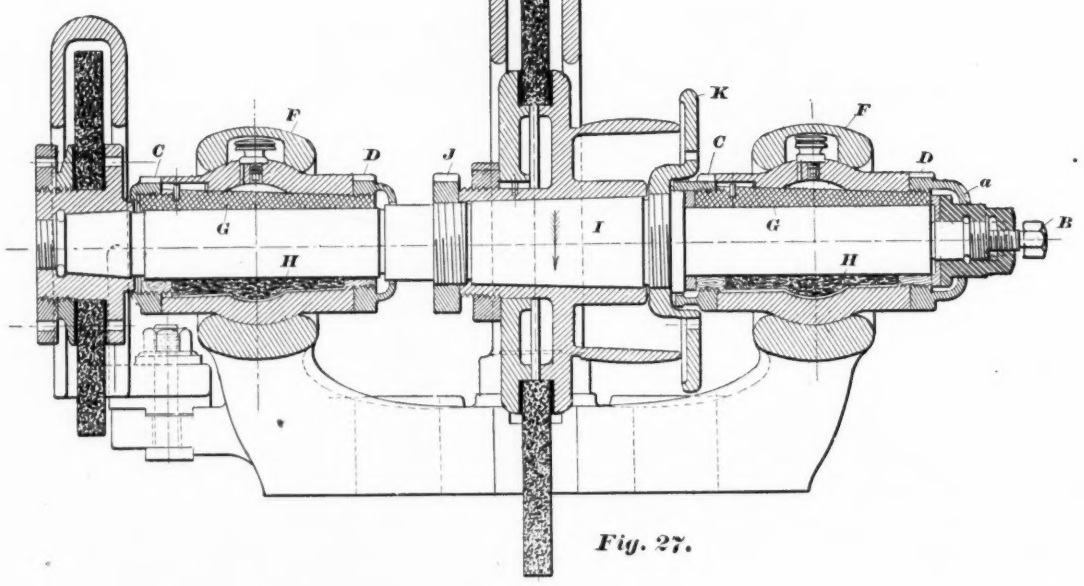


Fig. 27.

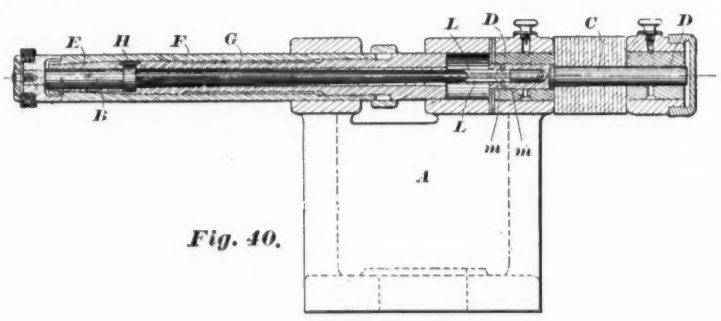


Fig. 40.

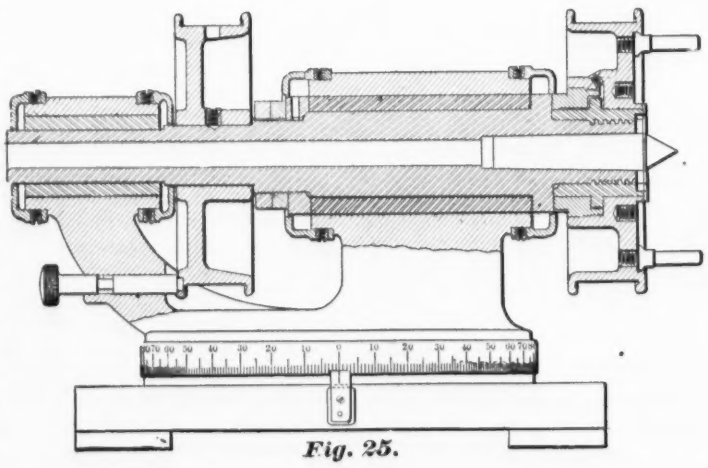


Fig. 25.

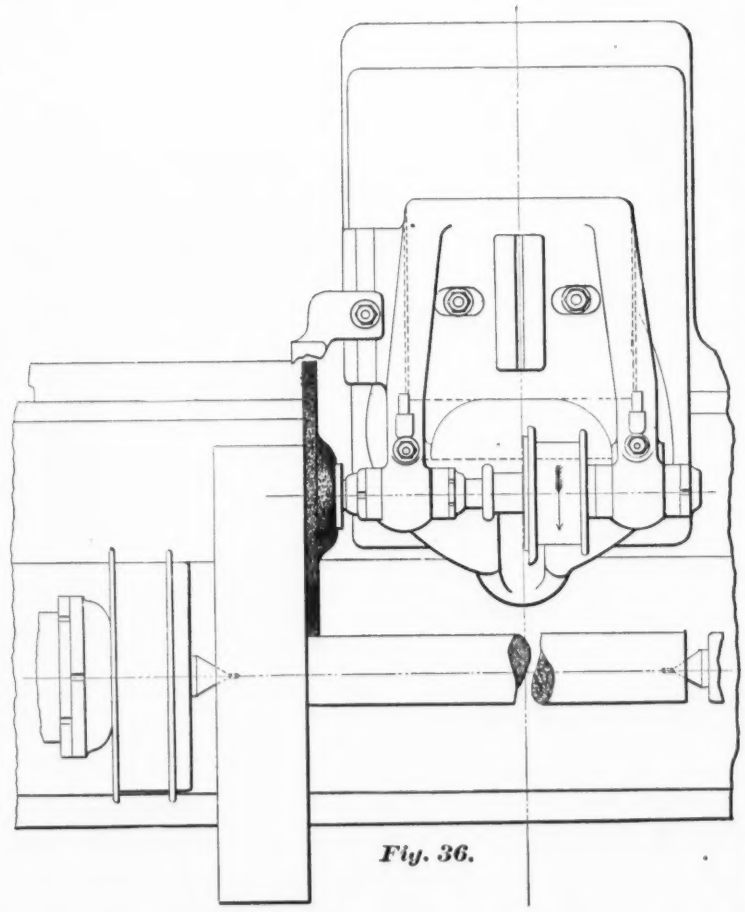


Fig. 36.

The overhead works consist of three shafts with two drums, tight and loose pulleys, etc., and are arranged to give any speed to the emery wheel from 1,300 to 2,000 revolutions, and twelve speeds for the work ranging from 36 to 800 revolutions. The motion of the emery wheel is controlled by the main shipper, while the work can be started or stopped independently by another shipper, thus allowing the wheel to run continuously during the changing or gauging of work. A friction brake is provided, by which the work is very quickly brought to rest when it is to be removed from the machine or gauged. The hangers are provided with self-adjusting and self oiling boxes.

The machine will swing work between centers 12″ diameter and 30″ long, while the platen may be fed several inches beyond that length. The swivel table will swing to either side of its central position to grind tapers up to 2″ per foot, or to 10° of angle. The wheel slide has a movement of 6″, and wheels can be used 12″ diameter and ¼″ thick, with a 2″ hole in center. The internal grinding fixture usually sent with the machine will grind holes up to 5½″ deep, 1″ and upwards in diameter, using wheels up to 2″ diameter. The machine is regularly provided with all the fixtures and accessories, shown in the upper illustration on page 1; weighs 4,050 pounds, and occupies a floor space 47″ × 152″. The same machine is made to take in 40″ between centers where desired.

The manufacturers are the Brown & Sharpe Mfg. Co., Provdence, R. I.

Give It a Chance.

There is — along with some good sense—a rare amount of nonsense published about electricity. This nonsense does a good deal of injury in the way of keeping back the legitimate use of electricity.

When a man undertakes to show that the heat generated by the combustion of coal can be worked through a steam engine, and then through a dynamo, and wires, with all the attendant losses, then be made to economically appear as heat, he brings about a general loss of faith in electrical matters. Men without pretensions to special knowledge know better, and they object to being humbugged.

Electricity may be an excellent medium for propelling street cars, but why is it not best to frankly admit that the processes of using it for such purposes are far from being perfected? It would help along, rather than hinder progress, to admit this evident fact.

Electrical enthusiasts tell us that electricity can be employed with a wonderful saving for moving heavy railroad trains, but they fail to fortify their assertions by any plausible argument. It is unwise, in the interests of extending the use of electricity, to make statements that every engineer knows, in the present state of the art, are not so.

We are not arguing against the use of electricity as a useful agent. In its way it is

wonderful. It gives us the best lights ever known. For small power, where the coal consumption is an unimportant factor, it has an assured place. In other places it is probably the best of intermediate agents. But in all the places where its utility is assured it is handicapped by foolish claims made for it in directions where its utility is neither assured nor probable. It ought to be given a better chance.

The Weston Triplex Chain Block.

Since the invention of the Weston differential pulley block, many years ago, the use of self-sustaining chain blocks has become very general. The great advance which these blocks made over any forms of hoisting previously constructed consisted in the fact that, without any ratchet mechanism or holding device of any sort, they would sustain the load automatically at any point, thus avoiding the necessity of making the end of the rope or chain fast, if, for any purpose, the operation of hoisting had to be interrupted.

The differential pulley block is so well known that a detailed description of its construction is unnecessary. There is, however, one point about its construction that is not as widely known as it should be, namely, the impossibility of attaining any very high mechanical efficiency from such a device. The great value of the apparatus lies in its convenience, and in order to attain that convenience the efficiency has to be sacrificed.

Since the introduction of the Weston differential block numerous other forms of chain blocks have been made and widely used. These blocks are either of the differential character, using differential gearing or pulleys, or are made with worm gearing movement. The object in both cases is to secure a self-sustaining action, which the introduction of the Weston block had already proved to be so convenient and practical.

The reason for this self sustaining action was not altogether clear to many people until Prof. Ball introduced a description of it into his treatise on experimental mechanics, in which he showed that the self-sustaining power of any hoisting device was due to an efficiency of less than 50 per cent. In order to make this point clear it will be necessary to distinguish between the mechanical efficiency and the velocity ratio. If there were no frictional resistance in a hoisting machine its efficiency would be one hundred per cent., so that if the operator pulled the chain down ten feet in raising the load one foot, there would be a velocity ratio of 10, and a corresponding relation between the load and the effort required to raise it, just as in the case of a lever; and a pull of one pound on the lifting side of the chain, operating over a space of ten feet, should raise a load of ten pounds on the hook through a space of one foot. As a matter of fact, under these circumstances the differential pulley block would only raise a load of a little over three

pounds, or, in other words, would have an efficiency of about 32 per cent. The remaining 68 per cent. of the effort exerted upon the chain is expended in overcoming the internal resistance of the apparatus.

A similar low efficiency is obtained in blocks operated by worm-wheel mechanism; and it is well known that worm-wheel gearing possesses a very low mechanical efficiency. These facts show at once why the load does not run back on such blocks when the hand chain is released. The load is less than the internal resistance of the block, and 32 per cent. cannot be expected to do the work of 68 per cent. These facts have been known for a long time, but have been allowed to remain unimproved, because it was thought desirable to retain the simplicity which existed in the differential block, and even at the present time, for many purposes, this convenient form of hoisting apparatus has many advantages.

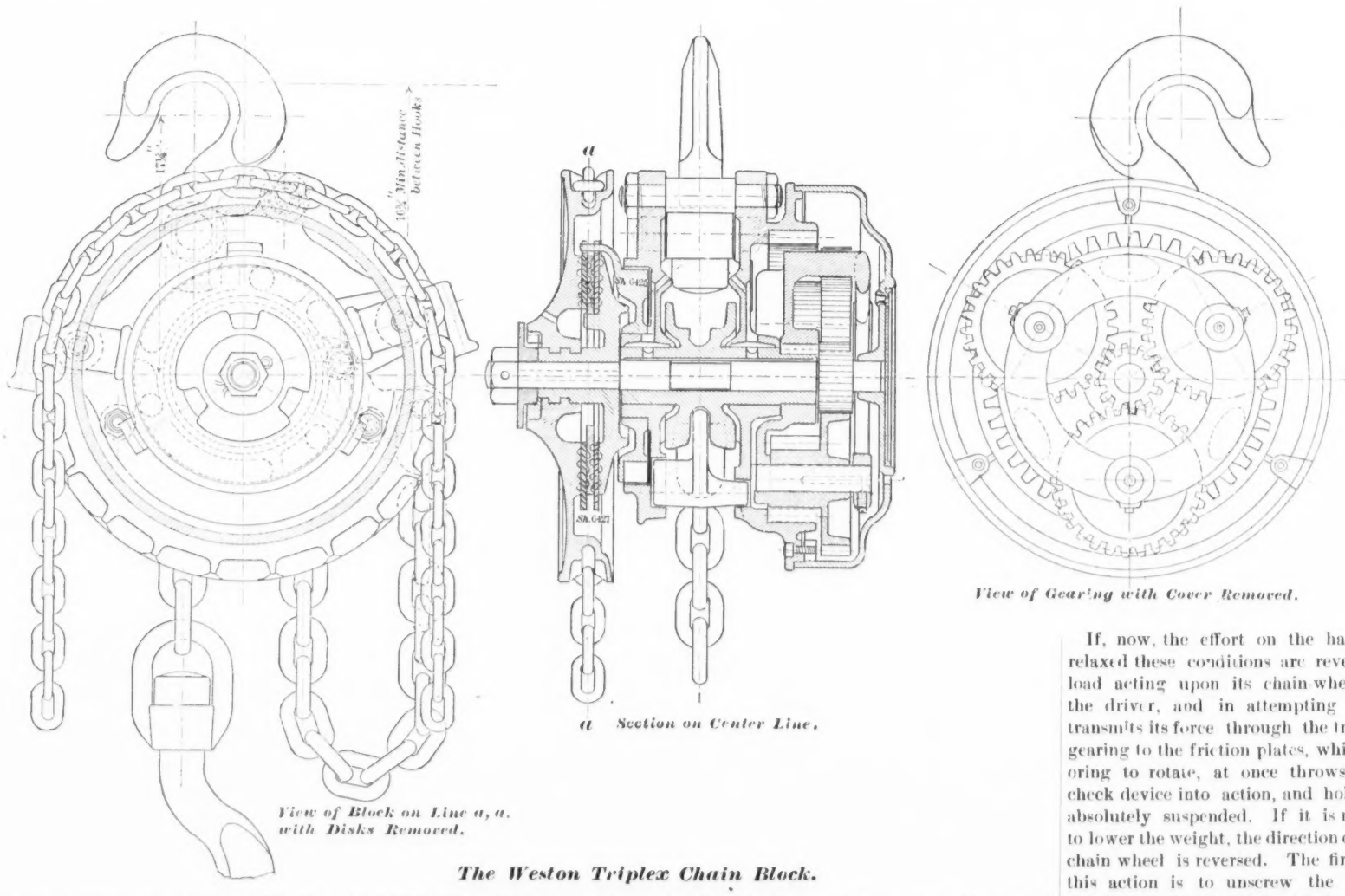
The original inventor of the differential block, Mr. Thomas A. Weston, has, however, been endeavoring to design an improved hoisting apparatus which shall possess the great convenience of automatically sustaining the load, and, at the same time, return a much greater proportion of the effort in useful work. This appears to have been most effectively done in the new chain block, the construction of which is shown very fully in the sectional detail drawings which are here illustrated.

In order to attain a higher efficiency than 50 per cent. it is necessary to separate the hoisting mechanism from the sustaining mechanism. The manner in which this has been done by the inventor will be evident from an inspection of the drawings. These can best be understood by first examining the hoisting portion of the device, and then studying the manner in which the load is automatically sustained. In the view to the right, and in the right-hand portion of the middle sectional view, the hoisting mechanism is fully shown. It is simple and powerful, and consists of a triple train of spur gearing. A central pinion gears into three spur planet wheels; these spur gears carry intermediate pinions, which, in turn, gear into an internal wheel, which is cast in one piece with the frame. The axes of the intermediate gears and pinions are attached to a frame or cage, which is keyed fast to the hub of the hoisting chain wheel, so that when the central pinion is revolved the pinions on the three planet wheels also revolve around the inside of the internal gear wheel (see view above), carrying with them the cage and the hoisting chain wheel.

This direct system of gearing gives a velocity ratio of about 30 to 1, and its hoisting efficiency has been demonstrated, we are told, by careful experiments to be fully 80 per cent. Of course, a train of gearing like this, exerting such a high efficiency, would be entirely incapable of sustaining the load when the hand chain is released; and in order to secure the self-sustaining feature a device, shown in the left of the central sectional drawing, and in the left-hand view, has been designed. This consists of a very ingenious combination of roller check and friction disk clutch mechanism, which, while simple in construction, requires careful examination to be fully understood. This friction brake, as it may be called, is mainly contained within the hand-chain wheel, shown on the left of the central view, and consists of a pair of friction disks of bronze, between which is placed an intermediate disk of iron. The flat surface of the hand-chain wheel forms one of the outer disks, and a plate, whose hub is fitted to a central spindle, forms the other outer disk, so that this set of friction plates forms an example of the well-known Weston friction clutch. The two bronze friction plates are held fast to the plate of the roller check device, while the intermediate disk is held fast to the friction plate which is keyed upon the spindle. The hand-chain wheel is not attached positively to the shaft, but is threaded upon the hub of the friction disk as shown, so that when rotated in one direction it will tighten the disks together, holding them as a unit, while, if rotated in the opposite direction, it will release the disks.

The roller check consists of three steel rollers shown in the side view on the left. These rollers lie in recesses, which are inclined toward the axis, so that they will wedge or clamp the disk in which they are placed very firmly, to prevent the working of the block when rotated in one direction, but immediately releases the disks from all frictional engagement with the frame when rotated in the opposite direction.

These elements, which take many words to describe, are really in themselves very simple, as an examination of the drawings will show. The action of the internal wheel can best be understood by considering the operations of hoisting and of lowering. In hoisting, the hand-chain wheel is revolved in the direction which first tightens it against the friction disks, and consequently drives the disk which is keyed upon the shaft, and through it the central pinion and entire train of hoisting mechanism. This direction of rotation always releases the roller check, so that it interposes no resistance whatever to the effort of hoisting, and the operator is able to realize the full efficiency of the hoisting portion of the block.



View of Block on Line a, a, with Disks Removed.

a Section on Center Line.

View of Gearing with Cover Removed.

The Weston Triplex Chain Block.

If, now, the effort on the hand-chain is relaxed these conditions are reversed. The load acting upon its chain-wheel becomes the driver, and in attempting to descend transmits its force through the train of spur gearing to the friction plates, which, endeavoring to rotate, at once throws the roller check device into action, and holds the load absolutely suspended. If it is now desired to lower the weight, the direction of the hand-chain wheel is reversed. The first effect of this action is to unscrew the hand-chain wheel from the hub of the friction disk upon which it is mounted This at once releases the pressure upon the friction disks, and while the roller check mechanism holds the bronze disks firmly from revolving, the reversal of motion reduces the friction, so that the iron friction disks acting under the pressure of the load begin to slip backward. They can only do so, however, to the same extent and at the same speed as the reverse motion of the hand chain wheel, for should the motion of the latter be stopped the iron friction disks will at once tighten upon the

bronze disks and increase the friction to a sufficient extent to prevent further motion of the load. In this respect the action of the hand-chain wheel and friction disks is much like that of a weight lying upon an inclined plane with a wedge between it and the plane. If the wedge is gradually withdrawn the weight will slip down, but cannot slip faster than the rate of motion which is given to the wedge, providing the angles of friction are properly proportioned.

This lowering motion is perfectly continuous in its character, and not intermittent, following the motion of the hand-chain, and being checked immediately when the hand-chain is stopped.

Since in this block there is no frictional resistance forming the holding power to be overcome, the brake which holds the load being entirely withdrawn from action during the operation of hoisting, it follows that in the "Triplex" block this serious loss is practically done away with.

Tests of this block have been made by eminent authority, but the publication of these tests seems unnecessary, since the principle of operation is shown so clearly in the cuts and description.

The Yale & Towne Mfg. Co., Stamford, Conn., are the manufacturers.

Steam Launch Norwood.

Mr. C. D. Mosher the designer of the celebrated steam launch Buzz, has recently completed another fast steam launch, named "Norwood," for Mr. N. L. Munro, of New York City. The great aim of the designer was to bring out a launch of high speed, consequently some of the capacity for carrying passengers was sacrificed so as to obtain sufficient room for the machinery and boiler required for the high speed. During a preliminary trial a speed of 30 miles an hour has been obtained, and it is expected that in the official trial this speed will be exceeded. The length of the launch is 63 feet over all; breadth, 7 feet 3 inches; draught, 18 inches; displacement 18 tons. Her lines are very fine, and the midship section below the water line is formed so as to reduce the skin friction to a minimum for the greatest displacement. The keel does not project below the hull. The keelson is of steel I-beam 5x3 x¼ inches. The frames are made of oak, 1¼ inch square, placed 8 inches apart. The planking is made of mahogany in two thicknesses; the thickness of the outer plank is $\frac{9}{16}$ inch, and that of the inner plank is $\frac{5}{16}$ inch. A layer of light canvas bedded in elastic cement is placed between the inner and outer thicknesses of the planking, which is fastened to the frames by phosphor bronze screws.

The engine is of an upright triple expansion condensing type; cylinders 9, 14¼, 22 inches, and 9 inches stroke, and develops 400 indicated horse-power. The weight of the engine is 2,000 pounds. The condenser has 512 corrugated tubes, and gives 500 square feet of cooling surface. Diameter of propeller, 35 inches; pitch, 7 feet; two blades.

The boiler is illustrated in Figs. 1, 2, 3 and 4. It has 26 square feet of grate surface, and about 1,000 square feet of heating surface. The tubes are made of steel, 1 inch diameter, solid drawn. The weight of the boiler and water is 2¼ tons; its length is 7 feet 3 inches; breadth, 6 feet; total height, 3 feet 6 inches. This boiler was specially designed for this launch by Mr. Mosher; it has several new and novel features. It will be noticed that, for the power the boiler has to furnish, it occupies but a very small space, and its center of gravity is very low, all of which are advantageous features of a boiler designed for a steam launch. Fig. 1 represents an end elevation of the boiler or steam generator; a portion of the casing is removed to show the interior. Fig. 2 represents a horizontal section taken on line 2, 2, Fig. 3. Fig. 3 represents a transverse section on line 3, 3, Fig. 2. Fig. 4 represents a vertical section on line 4, 4, Fig. 3. The same letters of reference indicate the same parts in all the figures. In these illustrations *a a* represent two horizontal water drums, which are arranged parallel with each other at opposite sides of the furnace *b*; these drums are placed just above the grates *c*. The furnace, as will be seen by referring to Figs. 2 and 3, is divided into two sections by an intermediate water drum *a'*, and a row of tubes f^2 extending upwardly from the drum *a'*, and arranged so that above their bent ends they form a close wall extending lengthwise of the furnace; the upper portions of the tubes f^2 are curved outwardly; every alternate tube extends over to the steam drum at the one side of the furnace, and the remaining tubes over to the steam drum at the other side of the furnace. The intermediate drum *a'* is connected by transverse pipes *a''* with the outside water drums *a a*, so that water from the drums *a a* enters the drum *a'*, and passes upwardly therefrom through the tubes f^2.

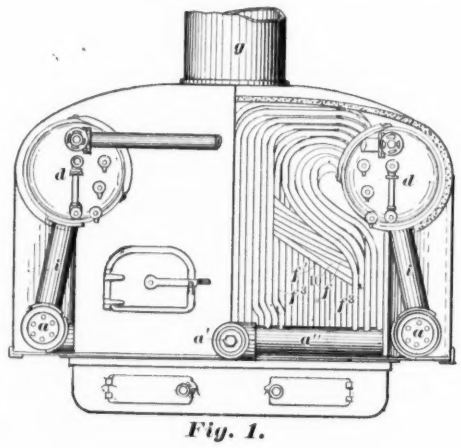


Fig. 1.

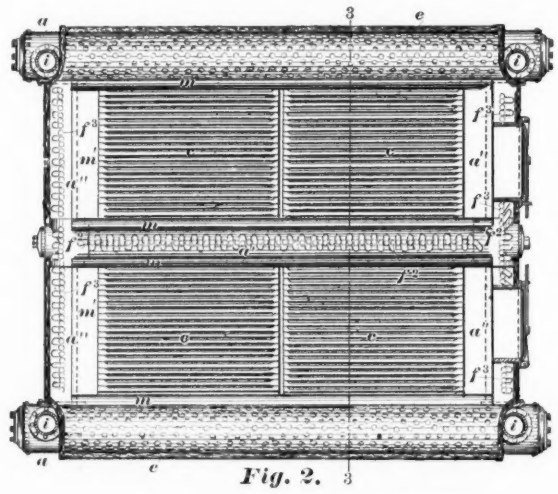


Fig. 2.

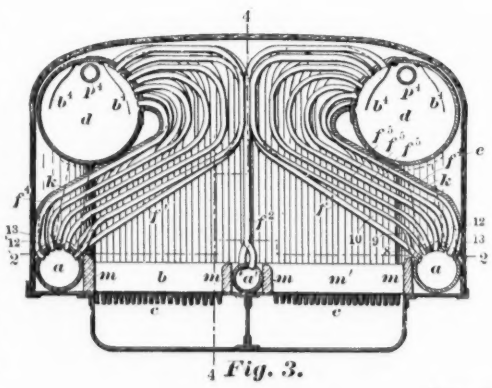


Fig. 3.

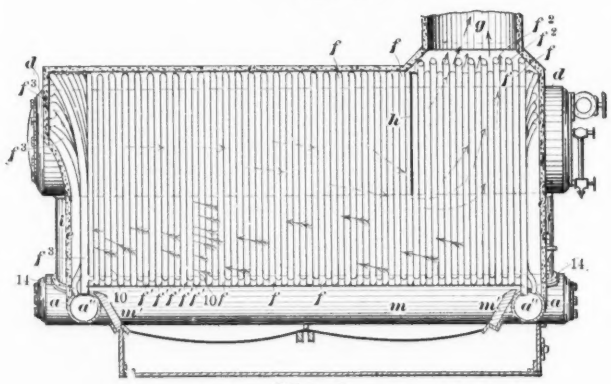


Fig. 4.

STEAM LAUNCH NORWOOD.

The tubes f^3 are connected with the transverse tubes *a''*; they extend upwards, and are bent at their upper ends, and joined to the steam drums *d d*. These tubes, f^3, spring from the pipes *a''* in two rows. Those of the outer row are bent inwardly, as shown at 14, Fig. 4, so that the tubes f^3 constitute closed vertical end walls, the front one being interrupted by the spaces for the fire doors.

The steam drums *d d* are placed above the water drums *a a*, and are practically outside the space which constitutes the furnace. They are arranged to bring their outer sides in a vertical plane with the outer sides of the water drums to accommodate the casing *e*, which encloses the whole apparatus.

Each water drum is connected with the steam drum by a series of bent steam generating tubes, *f*, *f'*, f^4, f^5. From the points of connection with the water drums, these tubes are bent inwardly and upwardly toward the center and upper portion of the furnace. They are then bent outwardly until they join the inner sides of the steam drums.

It will be seen that the tubes *f*, *f'*, f^4, f^5, are formed and arranged to expose their contents in a very favorable manner to the heat of the furnace, and at the same time enable the steam drums *d* to be located at a minimum height above the water drums *a*, thus giving the generator a low center of gravity, and making it in this respect particularly desirable for steam launches and yachts, and other crafts in which economy of vertical space is desirable.

The arrangement of the inner tubes *f* is such that these tubes along the forward portion of the furnace, or fire-door end, nearly to the opposite end, constitute a practically closed wall, made up of the inclined portions of the tubes.

The lower ends of every alternate tube *f* is bent, as shown at 8, Fig. 3, so that the whole form two inner rows at the points where they join the water drums, and come in close contact with each other just above the bend 9. The object of arranging the tubes to form a close wall, as described, is to cause the heated products of combustion to pass from the front toward the rear end of the furnace before passing to the outside of these tubes. To enable the products of combustion to pass to the outside of the tubes, a number of these tubes at the rear end of the furnace are made straight, as shown at *f'*, in Figs. 1, 3 and 4, creating the spaces 10 between the tubes *f'* and the intermediate tubes *f*. The spaces 10 permit the products of combustion to pass outwardly, as indicated by the arrows in Fig 4, into the rear portion of the space between the walls composed of the tubes *f* and an outer wall composed of the tubes f^4, placed next to the inner casing *k*. The lower ends of the tubes f^4 are mark 12, 13, in Fig. 3. The wall composed of the tubes f^4 extends the entire length of the furnace. The spaces between the inner and outer walls of tubes contain the tubes f^5, which are of the same general form as the tubes *f* and f^4, but are separated, so that the products of combustion pass freely around each tube.

With this arrangement the steam drums are protected from the direct action of the fire by the interposed tubes, and can be affected only by the radiation of heat from the hot gases that pass through the spaces 10 at the rear portion of the fire-box; hence, the liability of burning or injuring the drums by overheating is reduced to a minimum. As an additional protection to the steam drums, the partitions *k k*, previously referred to, are interposed between the lower portions of the steam drums and the furnace; these partitions lay close to the wall formed by the tubes f^4, as shown in Fig. 3.

The smoke-stack *g* is placed over the forward end of the furnace, as shown in Fig. 4, causing the products of combustion, after passing through the spaces 10, to travel in the opposite direction toward the forward end of the furnace, as indicated by the dotted arrows in Fig. 4, the tubes being thus exposed to the action of the heat. This arrangement is another important feature of the invention.

A baffle-plate or deflector *h* is placed across the upper portion of the furnace, just in the rear of the smoke-stack, as shown in Fig. 4, which causes the products of combustion to take a downward course, as indicated by the dotted arrows, before reaching the smoke-stack, and prevents the too direct escape of the products of combustion, and causing the same to act more fully upon the water in the tubes.

The products of combustion pass to the stack through the openings formed between the tubes *f* and f^2, the latter being raised above the tubes *f* forward of the deflector *h*, as shown in Fig. 4, leaving spaces between the horizontal portions of the tubes *f* and f^2 of sufficient width to permit the passage of the smoke and gases to the stack.

The ends of the steam drums are connected with the ends of the water drums by the pipes *i* for the return of water from the steam drums to the water drums. These return pipes are located outside of the casing *e*, as is shown in Fig. 2, and are not subjected to the heat within the casing; hence the descent of water through the return pipes to the water drums is facilitated.

Baffle-plates b^4, b^4, shown in Fig. 3, are attached to the upper portions of the steam drums at opposite sides of the perforated dry-pipes p^4, which extend through the drums, and are connected outside of the drums with pipes which conduct the steam to the engine.

The water drums are protected from contact with the fuel by the fire-brick linings *m*, and the transverse connecting pipes *a''* are protected by similar linings *m'*.

The water drums act also as mud drums, and have suitable blow-off cocks and hand holes to allow the removal of the deposits.

The tubes *f*, *f'*, f^2, f^3, f^4, f^5, are expanded in the drums and pipes by special tools devised for this purpose.

The adoption of two steam drums, *d*, not only makes the boiler symmetrical, but it gives a greater height of furnace in proportion to the total height of boiler, than could be obtained with one drum; and the water capacity is increased so that a sudden lowering of water level in the boiler when the supply of feed water is interrupted is prevented.

The circulation of water was found to be very satisfactory, and the boiler made ample steam to supply the comparatively large engine. The boiler is patented by C. D. Mosher, Amesbury, Mass.

Production of Pig Iron.

A recent issue of the *Bulletin of the American Iron and Steel Association* says:

"We present in this issue another notable advance in the production of pig iron in the United States. The total production of pig iron in this country in the first six months of 1890 was 5,169,737 net tons, or 4,615,837 gross tons, an increase of 754,653 net tons over the production in the last six months of 1889, when we produced 4,415,084 net tons. Each half year, except one, since July 1, 1885, has witnessed an increase, in most instances a very heavy increase, over the production of the preceding half year. But the increase in the first half of 1890 over the last half of 1889 has eclipsed all previous half-yearly increases.

"Each important pig-iron producing State shared in the increased production in the first half of 1890 over the last half of 1889

except Michigan and Tennessee, but Michigan made more pig iron in the first half of this year than in the first half of 1889. The proportion of Pennsylvania in the total production in the last half of 1889 was 49 per cent.; Ohio, 14 per cent.; Alabama, 9.6 per cent., and Illinois, 7 2 per cent. In the first half of 1890 the proportion of Pennsylvania was 49.2 per cent.; Ohio, 13.2 per cent.; Alabama, 8.9 per cent., and Illinois, 6.8 per cent."

LETTERS FROM PRACTICAL MEN.

Proving Square Root.

Editor American Machinist:

In Question No. 350 of your issue of the 4th inst., J. P. P. asks to be corrected in manner of proving square root. It should be: Divide the sum of the digits of the root by 9, square the remainder, and divide this by 9. The last remainder should equal the remainder obtained by dividing the sum of the digits of the square by 9.

J. G. ALDRICH.

Water Necromancy.

Editor American Machinist:

Apropos of the remarks made by W. H. Booth, on "Water Necromancy," would say: Sometime early in the seventies, a proprietor of a small foundry in Mid Somerset, England, wishing to drive a well for water to supply the boiler, hired a "professor of twiggery" to locate the spring, which he did, but there was never a good supply. But what I wanted to say is, there were about a dozen men working there, and most of us were skeptical on the "twig business," but to prove his power, the man proposed we put three hats on the floor of the shop, which, by the by, was made of mud (clay), and if we would put a watch under one of the three hats while he was absent, he would tell which hat it was under by holding the twig over them, providing there was no other metal present, and to the surprise of most of us, the end of the twig turned readily over the watch, which was a silver one. He also informed us that he was the father of a family of boys, but only one of them had this power.

WM. NEWTON.

Laying Out Sheets for a Conveyer.

Editor American Machinist:

The laying out of sheets for a conveyer is at once a very interesting and practical problem in sheet metal work. In the language of descriptive geometry, it is called the developable helicoid, or a single curved surface with a helical directrix. Referring to Fig. 1, and taking Mr. J. T. Gardham's figures as a basis for our dimensions, let us proceed to find our development of pattern sheet. Let M N (the outside diameter of 3″ pipe or 3.5″) be the horizontal projection of cylinder upon which the sheet is wound. Let M', N', S', T', equal vertical projection of the same. Let the Figs. 1, 2, 3, etc., and 1′, 2′, 3′, etc., each represent respectively the horizontal and vertical projections of the helix, the pitch of which is 13″. Let A B equal ground line or the intersection of horizontal and vertical planes of projections. In plain language, M N is the plan, M', N', S', T', the elevation and A, B, the plane of support of our figure. If an indefinite straight line be revolved about the cylinder, and at the same time be kept tangent to the helix, it will describe the above named surface. Every position of this line will make equal angles with the horizontal plane, and will intersect it in the points 1″, 2″, 3″, etc., describing an involute curve. If this surface be intersected by a cylinder E, F, E', F', we have our *original surface* in projection.

Draw M, N, and M', N', T', S', divide circle into any number of equal parts, in our figure 12 parts. Draw radial lines and lines perpendicular to them. Construct involute curve, or the curve traced by an element of surface in its revolution about the cylinder. The lengths 1 — 1″, 2 — 2″, etc., equal lengths of arcs 1 — 0, 2 — 1, etc. (Fig. 1), and points 1″, 2″, 3″, equal points of curve. Let L, K, be an element in a plane parallel to vertical plane of projection. Therefore the line L, K, L', K', is shown in its true length in the vertical projection. This line pierces the outer cylinder in point c — c'. Therefore, this line C — K. C' — K' is an element of our required surface, shown in true length by C' — K', and which we shall use in our development. The lines in vertical projection show different positions of same element in its revolution about the cylinder and tangent to the helix.

To draw the radius of curvature of the helix or the developed radius, draw N', P' parallel to L', K'; draw P' Q' perpendicular to N', P', ∴ N', Q', equal developed radius of curve. Now to find development:

Draw O'', N'' (Fig. 2) equal to N' Q' (Fig. 1). Divide into 12 equal parts; draw radial and perpendicular lines as before. Find true lengths of elements from Fig. 1, by taking the length of K' — L'; divide into 3 parts, and give to each element as many parts as are denoted by the figures; as 4 — 4″ has 4 parts, or equal to true lengths of each element, from point of tangency to where it pierces the horizontal plane. C, C' are the projections of intersection of element K' C', with outer cylinder F, E, F'', E'; therefore K', C', is the true length of our outside radius of development, or O'', F'', in Fig. 2. Cut sheets to this outer diameter, split in N'' F'', and rivet next section at N'', F''. Mark the helix of screw on your pipe or shaft by taking a piece of paper of proper length and inclintaion, then bend metal to conform to this line. Try a paper pattern first.

L. A. BUCHANNAN.

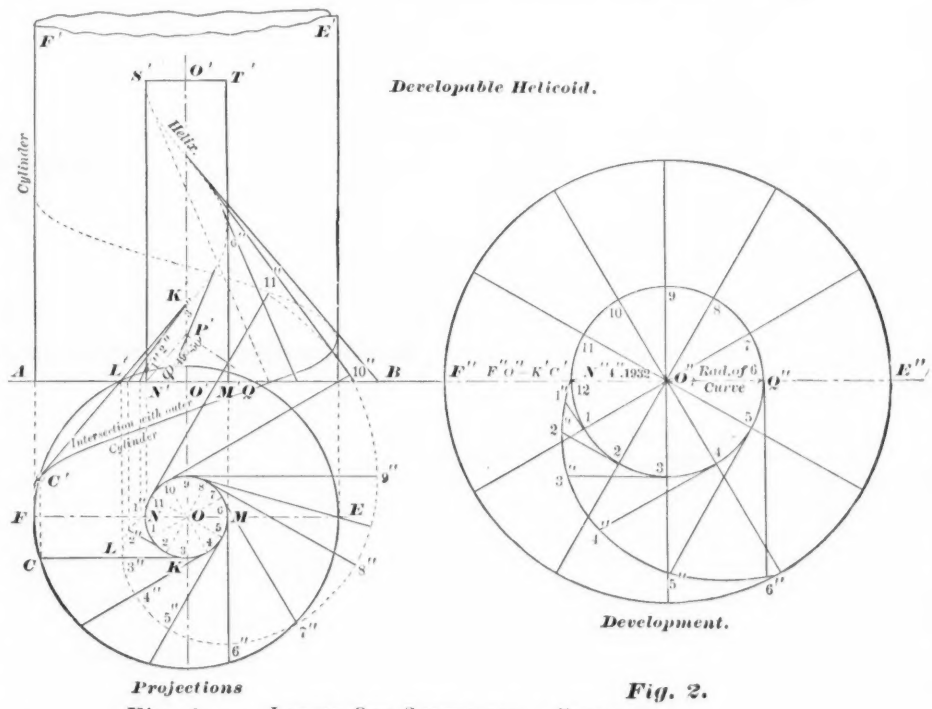


Fig. 1. LAYING OUT SHEETS FOR A CONVEYER. **Fig. 2.**

A Curious Case.

Editor American Machinist:

I have heard of a great many peculiar accidents occurring to men employed on machines, but I think the one that came to my notice yesterday caps the climax.

A boy was engaged in working on a small spindle, held in the chuck on a lathe. In the end of this spindle was a half-inch tapped hole. The boy placed the end of his little finger in this hole, while the lathe was running, and of course the finger was drawn in by the thread. He stopped the machine quickly enough to prevent twisting his finger off. He then took the piece out of the chuck and undertook to unscrew, but found this impossible without seriously injuring the finger.

The only way out of the predicament was to place the spindle in a bench-vise and hacksaw the end off close to the end of the finger. The piece was then placed in a planer, and a slot was cut in both sides, lengthwise, to within about one thirty-second ineh of the imprisoned finger. This was a slow operation on account of the metal heating, and becoming unbearable to the patient, in which case it was necessary to stop and cool it with water.

After the planing operation was completed the piece was placed in the bench vise again, and a wedge driven into one of the planed slots, which spread the piece open, and allowed the much mutilated member to be removed.

The whole operation took just an hour. No pain was felt by the boy until the piece was wedged apart. HARRY E. BILLINGS.

Critical Notes.

Editor American Machinist:

I have been reading with much interest the papers on worm gearing which have been appearing in the AMERICAN MACHINIST, and I have been disappointed in not finding as many facts in regard to the subject as it would be desirable to know in designing a worm gear for a given duty. I have not access to the paper by Mr. Lewis, referred to by Mr. Grant, but the reference to the diagram of results indicates that the wheel used with a worm of 5° angle of spiral was a straight-faced spur wheel; and if that be the case the experiments do not show the best results that are possible with a concave face worm-wheel.

Robert Briggs considered worm gearing a very efficient method of transmitting power, and devised an improved method of designing such gearing, which, he claimed, gave excellent results. He said it was necessary that there be no spring in the worm shaft, and no side motion of the wheel rim or end motion of the wheel shaft, and if these points were attended to the friction would be as low as one per cent. He says nothing, however, as to speed or allowable pressure of contact of worm against the wheel teeth. As to the speed at the pitch line, it is obvious that depends greatly on what the pressure of contact is; for I know certainly of worms used on elevators that have a velocity of much more than 200 feet per minute at pitch line, and yet they are durable, and the friction is so small that a brake is needed to keep the elevator from running down, even when not loaded. I know of a cast-iron worm on a foundry crane, of twenty tons capacity, in which the speed at pitch line of worm is 450 feet per minute, and it has been in use over four years, and looks good for two years more at least. This crane handles fully fifty tons of material daily.

I think the durability of worms in such cases is due to the fact that the pressure on the teeth is not excessive, the motion is not continuous in one direction for a long time, and the wheel teeth and worm are well shaped.

According to the diagram given, the efficiency increased with the speed, and that is not contrary to experience with friction of journals of shafting and other surfaces, where experiments with a given pressure fixes the speed of the surfaces at a point where the conducting quality of the materials is just enough to dissipate the heat generated by friction, and if one-half the pressure is removed the speed may be increased without harm.

I do not think any mechanic will be content with the statement that 200 feet per minute is the economical limit of speed for cast-iron worms, unless it is known what pressure there is at contact surfaces. The experience of Mr. Christie, as stated, does not appear to prove that is the limit of speed in all cases, for in that case the speed was increased, while the pressure of contact was not relieved a corresponding amount, and the result was the worm could not conduct and distribute the heat away fast enough.

I do not see any reason why the general rule that a decrease of load will allow an increase of speed would not apply to worm gearing as well as other rubbing surfaces. It is no doubt true that worm gearing at best will not transmit as large a percentage of power in proportion to the speed of contact surfaces as some other forms of gearing will, but I have no doubt experiments could be made which would determine their maximum efficiency with various materials at different speeds, and thus get data that would enable us to design worm gearing for a given duty with some degree of assurance as to what the results would be.

BELL CRANK.

"Divining" for Water.

Editor American Machinist:

Reading Mr. Booth's account of the man with the hazel twig locating subterranean channels of water, reminds me that some fifteen years ago I saw one of these water wizards, who was in the employ of parties who were going to sink a well for a supply of water for condensing and fire purposes. This man was a brick mason, of powerful build, and with a complexion that indicated his familiarity with that part of the ladder where it is said there is always a plenty of room, or else an over-indulgence in *spiritus frummenti*. He would grasp the forked twig, as described by Mr. Booth, and stride over the ground in parallel lines, and the large end of the twig would move from the slightly inclined position in which he held it to nearly a vertical one, with the free end pointing to the ground, and when in that position he would shake his head, as a signal to his employer or accomplice to mark that spot as one where water would be found. His face would twitch nervously, and after the strain was over he would succumb to great actual or feigned exhaustion.

Believing, like Brett Harte's "Jim," that "spirits don't fool with the levers much," I looked upon the whole business as a farce, and out of place in this nineteenth century; yet it is but fair to state that they got water where he "divined," also in another place where he did not. It is also fair to state that none present, including myself, who risked the sacrilege of trying it, could make the twig but slightly dip by twisting the ends, as I had expressed myself as believing he did. But whether it was a lack of strength, skill, or of divining power on our part, I must admit that the slight movement we could give the twig was but a burlesque of his performance with it.

To show that there are still persons who claim to be able to locate unseen waters, I enclose a clipping, taken from a local paper printed in Central Massachusetts, the present month:

Frank Hamilton has just sunk a well near his house. Mr. H. possesses that rare gift of locating water by the use of an apple bough.

PETER H. BULLOCK.

A Correction.

Editor American Machinist:

In reading my instructions for making white prints, I wish to call attention to an oversight on my part. In the four combinations B, and in the order given, the bottles should be given a new set of numbers, one to four inclusive; these are the four numbers used to make C. J. L. BIXBY, JR.

It is announced that the year's cotton crop of the United States is 7,311,322 bales.

Theory of the Feathering Wheel.

BY LIEUTENANT PRESTON H. UBERROTH, U. S. R. M.

The feathering paddle-wheel is of English origin, and up to recent years has never been extensively adopted in this country. In view of the fact that many of our large steamers are fitted with this system of propulsion, it may not be out of place to investigate the theory of its construction and action.

In the ordinary radial wheel the paddles, or "buckets," are rigidly fixed to the frames of the wheel, while in the feathering system the object of the combination is to make the paddles while immersed move edgewise relatively to the water in the paddle-race—a uniform current moving horizontally with respect to the axis of the wheel, and with a velocity equal to the rate of revolution of the "bucket" journals about its center.

Having recourse to the accompanying figure, in which A is the axis of the paddle wheel, B that of the eccentric, and $L\ B$ representing the surface of the water, let M, N, O, P, etc., be the axis of a paddle at various stages of its motion about A; $M\ E$, $N\ F$, $O\ G$, etc., the *stem lever* of the paddle at various positions, and $B\ E$, $B\ F$, $B\ G$, etc., the positions taken by the *guide rod* joining the eccentric with the *stem lever*. Assume P to be the point of deepest immersion, and from it draw the vertical diameter $P\ A\ M$. At the point Q, where the axis of the paddle is about to enter the water, resolve its circular velocity into two components, one normal or perpendicular to the paddle, and the other tangential or parallel to it. Now in a similar manner were we to resolve the velocity of the particles of water in the paddle race, we would find that in order that a paddle when immersed should move edgewise to the water the normal components of the journal and water must be identical.

Since the rate of P is identical in amount and direction with the water in the paddle-race, and the component velocities along the chord $Q\ P$ being the same, it must follow that the paddle at Q must become a normal to the chord. The paddle at Q may now be drawn, and upon being produced will be found to intersect the circumference in its highest point M, a fact self-evident, since we have but inscribed a right angle in a semi-circle.

Assume $\varphi\ \varphi'$ a convenient depth for the paddle, and on the perpendicular at its middle point lay off a length equal to about three-fifths the depth of the paddle.

Ascer ain now the center of a circumference which will pass through the three points $I\ H\ G$ for the eccentric axis, and with radius $B\ H$ describe a circle passing through $I\ H\ G$. This will be the *locus* of the extremities of the *radius bars* at all positions of rotation. Join $I\ H\ G$, etc., with B for the length and positions of the *guide rod*. The *driving rod* is rigidly fixed to the eccentric strap in order that the motion of rotation may be transmitted to the paddles, the remaining rods being loosely joined to the strap by pins.

In order to ascertain how near the paddle approaches to the *driving rod*, and to what extent it may be necessary to cut into the rod so as to prevent contact, we have simply to join $A\ B$, and produce it to meet the circle in B'. Lay off the *stem lever* $B'\ C$ and draw at right angles to it the paddle $D\ G$ The distance of D from $B\ B'$ is the nearest approach of the paddle to the *driving rod* throughout its revolution.

During the time the paddles are immersed their motion is almost exactly as theoretically demonstrated, although above the surface their action is somewhat different, as is indicated by the diagram. In practice it is impossible to carry out the theory exactly, but it is fulfilled with an approximation sufficient for all practical purposes.

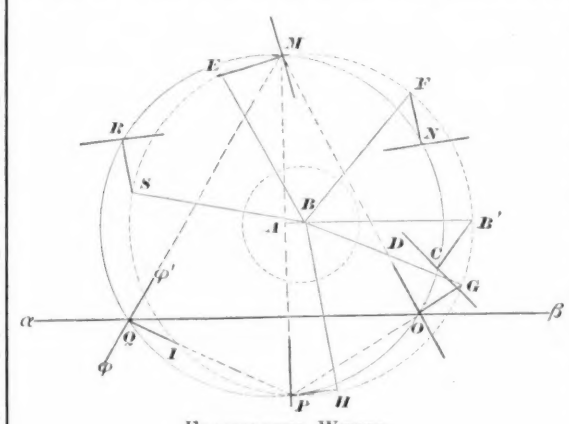
The *Evening Sun*, in a recent effort to show where there is room for invention, puts forth the remarkable statement that the use of the triple expansion engine has reduced coal consumption to four pounds per horse-power per hour. Comment would be superfluous.

Engineering Notes from England.

BY W. H. BOOTH.

Every profession and every trade has its own peculiar language, as little understood by other professions as an unlearned foreign tongue, and even in our own special line of mechanical engineering there are dialects which are but imperfectly understood by some branches which have their own dialect.

Sometimes, when traveling about, I meet with men who will begin to converse with me, apparently under the impression that I am even as they are, and it is with difficulty that I can follow them until they find me out and speak straight English. In a recent book of the holiday type, a man describes himself as having read some medical work,



FEATHERING WHEEL.

and rising with the conviction that he had everything the matter with him excepting one complaint—housemaid's knee—any symptoms of which he failed to discover. Doubtless he did not expose himself to this complaint by too close attendance at his prayers. Laymen reading the literature of any trade or profession are similarly liable to gather false and exaggerated notions from want of properly comprehending the full and exact value of technicalities.

Daily papers are singularly inapt in their references to mechanics, and produce some wondrous specimens of mechanical action. In one Lancashire paper an account of a factory-engine breakdown described the "vacuum" as having "dropped into the clock-box," and sundry other curious actions. The *Daily Telegraph* was once notorious for its errors, and described the method of getting a locomotive round a curve as including "shortening the stroke of the piston," "shutting off steam and opening the regulator" (*i. e.*, throttle). The only paper which produces almost invariably sound engineering being one which makes up for this by a double dose of sin on all questions of political importance, in which it is always wrong. In a busy life one moves in very small circles, and is apt to think all the world is within the same circle. A few days ago, a man traveling to the Midland Railway meeting at Derby, he being a shareholder of the line, it appeared, said to me that he had no idea whatever as to how a locomotive moved under the action of steam.

I am constantly meeting with men who inform me in all earnestness of some wonderful invention which is going to revolutionize everything. A few days ago this took the form of a means of so applying the force of water to a contrivance down a well as to force a lot of water to the surface, besides returning the working stream also. It is rude to contradict, so I listen and say nothing, long ago convinced of the inutility of trying to explain things to the uninitiated, who, after all, won't believe you, but set you down as "another self-opinionated engineer," who is "so blinded by old-fashioned ways that he won't believe anything new." There are probably never less than a dozen men in existence at any one time who are trying to get behind some natural law with a spring device or a system of weights and levers, or elliptic gearing. Few of them contrive machines to run so long as Keeley's motor, or to be so profitable (to the inventor).

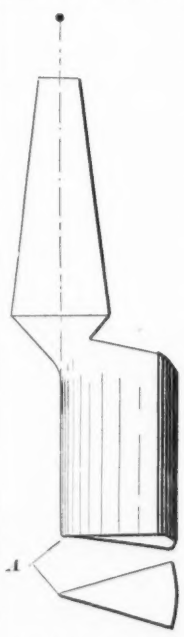
Mechanical engineers may rest and be thankful for a time, however.

For several years such trifling details as steam engines, locomotives, and sundry other playthings which mechanical engineers have designed to do more or less work, have fallen under the ban of displeasure of a set of men who, having taken to do much wire plastering with soft solder, have called themselves electricians. As a fact, not one electrician in ten is other than a sort of self-glorified tinker, with no knowledge of the force with which he ought to deal, and with a loathing of anything more mechanical than a magnified style of philosophical toy making.

These creatures have so misread the duty of a true electrician that they have been loudly clamoring for everything to be carried out by electricity, and having unfortunately been taken at their own valuation, have had a chance given them of proving their ability. Like everything pushed too rapidly into untried duties, electricity, in the hands of these self-anointed ones, has again gone wrong, and after the late fiasco at Auburn may we not look for less of the unseemly slopping over of the half-taught soft-solderer, and a better field for the true electrician, who will readily admit that beyond small work electricity is not yet applicable? It has been for years customary to define electricity as a fluid. However unsuitable such a term may be to what is, after all, simply — (what?) it would be better to treat it as a fluid, just as we do high-pressure steam. There has been far too much highfalutin by men who, to cover their own ignorance, have used long half-dollar words to express what no fellow could understand.

Steam engineers have worked for years at steam, and acknowledge their ignorance even yet of the source of the power they apply. Why, then, such extravagant claims for the newer energy? and how great the discomfiture! Shade of Kemmler!

Granting that tramcars have run and are to-day running and paying with electricity as a link between the car and the motive power, it seems early to prophesy on the extinction of steam locomotives by any system of electric traction yet brought out. When electric traction is fully developed, it will probably be as far different from the methods now followed as is a Corliss engine from Hero's reaction jet. Electricians have been far too previous, and now let us hope they will give us a rest.



Talking of new ideas reminds me that to-day I was shown at work one of the new square drilling machines. As a piece of machinery this drill is worth notice, anyhow. I saw it drilling brass, and it did drill holes practically accurately square, and with sharp corners, too, and a slight alteration changed to octagonal. The spindle revolves at a fair speed, with a sort of rolling motion upon a central ball swivel joint, and at the upper end of the spindle is a closed cam-box, in which the square is generated, but which was not opened in my presence.

The drill tool itself is peculiar, consisting of a socket end and a blade of triangular section, the apex of the triangle, which is opposite the narrower side (which is not flat, but convex), being the center line of revolution of the drill spindle about its own axis. The sharp edges of the flat-foot end of the drill do the bulk of the actual work, but upon the point A depends the cutting of the square boundary of the hole.

There is a lot of making in this tool which the ordinary observer will probably overlook, and the speed of work is not rapid by any means.

If the machine is sold at a moderate advance upon a plain drill there is always the chance that it would be taken for general round drilling and occasional square drilling, but if costly its use can be but limited. Its most rational use would be the drilling of nearly square holes in boiler plates, so enabling smaller rivets to be used of equal area, and giving more plate area between holes. For boilers or other tension joints it would be valuable, there being no objection to the use of square rivets, or rather of square rivets with well chamfered corners—irregular or immature octagon. There is certainly great merit in the machine as such, and the specimen I saw was well made, but whether investors will see such merit in a year from now remains to be seen.

Concerning the Saturday half-holiday, you have a note that opposition to it is ceasing. It seems late in the day to read such a note in an American paper. How long it is since there was no half-holiday on this side passes my knowledge, but I have a faint recollection of an elderly man telling me it did not exist in his youthful days. It must be forty years ago at least. How it happens that America should be behind on this point is unaccountable, but the absence of the half-Saturday is looked upon as a sign that the workingman of America cannot be ahead of his brother of England, in spite of higher wages.

Here the half-holiday extends all the year round, and if I choose I can be fifty miles away from London, and by the sea, before 3:30 P. M. I am not aware that the Saturday let-up exists on the continent of Europe further than that work stops at something like 6 P. M., apparently in order that people may buy food to go through another week's trial; but it is general throughout Australasia, and all Anglo-Saxony, I believe, but America. Its absence must surely make life one "demnition horrid grind," as Mr. Mantalini would say.

Have been using lately some American-made saws on steel. They are cheap things, to be thrown away when dulled, not to be sharpened again. They are quite soft, like sheet-iron, along the back, the teeth only being hard, but all in one piece with the back part.

The saws can be bent double without further injury than cracking through the hardened strip, but this by no means made them useless, for the toothed strip seems quite of a piece with the back, so that half a dozen fractures could be made and the saw still remain of use. They were new to me until lately, but every one ought to know of them, for a new saw costs less than time and files used in sharpening an ordinary metal saw, and the teeth, too, are so hard that they last really well on the tough back strips.

Boiler inspection seems to be again exciting some attention. On this side, too, there is some acrimonious discussion going on. It would seem that the yearly death rate from boiler explosions of all kinds in these islands —both preventable and non-preventable—has now fallen to less than six per annum as the highest return, a return for five years showing under five as a yearly average, and a third showing five and one-half, or thereabouts. This is taken by the boiler insurance companies as due to their continued efforts, by others as due to the greater probability of fatal explosions being followed by a Board of Trade inquiry and a trial for manslaughter, but it is more probably a result of steel homogeneous plates, better knowledge and better care, combined with the above causes, also, no doubt, and perhaps due in a large measure to the decrease of boilers of the under-fired type. In spite of higher pressures, too, the stress on a boiler is now very likely a less fraction of the ultimate strength than formerly.

Under fired boilers do not easily run short of water, and therein are safe, but they are looked on as unsafe, the shell being exposed to the direct action of fire. How the chief engineers of English boiler insurance companies would get along in a similar capacity in America is not to be considered too curiously, but probably they would be found on Blackwell's Island very soon, for American pressures are extravagantly high

to English notions, and taking pressures into account the number of American explosions is, perhaps, not very high. American boiler steel, too, is of good quality, though is not found to range so high in tensile strength as can be got here of full ductility—so at least an American boiler maker has informed me—steel for shell plates on this side being found sufficiently ductile up to 33 tons (2,240 pounds), or nearly 74,000 pounds.

The Money Value of Solid Emery Wheels.

By T. DUNCAN PARET.

(A Paper Presented at the Indianapolis Meeting for the Advancement of Science.)

[We published an abstract of this paper last week, and, by the courtesy of the author, are enabled to give it entire this week.]

During the last twenty-five years the use and manufacture of solid emery wheels has so increased that an important industry has been created. The use of such wheels is steadily and largely increasing, both in this country and in Europe. In many large and progressive establishments there is a strong faith in the great future extension of this industry, and nearly all users admit that they do not use near as many solid emery wheels as they ought to use, and that those they do use are not worked to the best advantage.

The reasons why more are not used are simple, and are freely admitted by the users. It is not the first cost of the goods which hinders their freer use. This cost, in fact, is now less than one-half what it was twenty-five years ago The main reason for the slow increase of emery grinding plant is lack of time and space. As emery grinders run at a very much higher speed than do the lathes, planers, drills, and general machines of an ordinary shop, such grinders cannot be run by a belt directly from the line shaft, and hence their erection necessitates intermediate and countershafts. Furthermore, such grinders need to be set near lathes, planers and other high-priced machines, and such setting necessitates the use of suction fans, or dust exhausters. whose high speed also calls for countershafts. Thus the emery grinder, whose first cost is small in proportion to that of lathe and planer, has its importance rated in proportion to its cost, while the time required to properly erect it is out of all proportion to that demanded by the more costly machines.

As emery grinders should be interspersed among the other machines, rather than be located apart by themselves, their later and increasing introduction in shops previously arranged for and supplied with the standard varieties of machine tools, necessitates not only more space, but frequent re-spacings of the other machines.

Hence the general admission that the shop ought to have more emery wheels at work, but that time and space are lacking.

The reasons which prevent those wheels actually in use from being worked to the best advantage are also simple. Owing to the high speed and the trouble of countershafting, a correct standard speed is seldom arranged for, some rough approximation being deemed sufficient. Owing to high speed there is more than usual likelihood of slip of belt—a factor to which few mechanics attach enough importance. A still more important reason is the excessive vibration of the emery wheel. This vibration is due to the light weight of the grinding machines, and the instability of floors and work benches. It is almost impossible to manufacture solid emery wheels which are in perfect balance, and an unbalanced wheel jumps. This jumping sometimes lessens and sometimes ceases entirely, if grinding machine is heavy and bench or floor solid. If these latter are unstable, the jumping is imparted to them. Even wheels of originally perfect balance soon get out of balance, owing to unequal wear, if the metal being ground is applied by hand instead of automatically. The amount of vibration due to the revolution of an unbalanced body at the speed of a mile a minute can hardly be calculated. The number of revolutions per minute is so great that the hand cannot preserve continuous contact between work and wheel. The metal being ground is struck and thrown off by the wheel, a large portion of whose surface revolves untouchod by the metal before contact is again secured.

American built emery grinders are too light in weight as a universal rule. The users of solid emery wheels do not realize the loss in money value due to the imperfect mounting of such wheels, and therefore are unwilling to pay the price needed to secure substantial machines. In this matter a radical change must be made if users are to secure the greatest possible profit. In many cases emery grinders are placed on unsubstantial floors, and we have visited factories where a few additional posts to support the floors would have made work easier, and the product both cheaper and better.

The facts thus far recited are simple, and will probably be freely admitted by most mechanics. A fact far from simple, however, is that no exact data exist as to the money value of the process of grinding by solid emery wheels, as compared with other and older processes of metal shaping and removal. This fact is largely dependent upon another, namely, that no well-known and easy method exists by which the comparative money value of the various makes of solid emery wheels can be ascertained. As a consequence, the reputation and commercial success of many makes of solid emery wheels are purely factitious, and bear slight relation to real money value.

In many cases the choice of a solid emery wheel depends entirely on color. In some sections of the United States at the present time a prejudice exists against all dark-colored wheels. In some cases porousness or openness of texture is considered the characteristic of a first-class solid emery wheel, and the value of some wheels has been boasted of because it was claimed that water would flow through them, and that "you could blow through them" Value is set upon some solid emery wheels because they are said to be composed entirely of mineral ingredients, and to contain no glues nor gums. Some are used on account of faith in the special brand of emery they are said to contain, while the virtue of others is based on the peculiarity of what is called the bond. At one period the sonorous name of Itacolumite was a terror to emery wheel salesmen, and in the unknown they found the immense. At another time Infusorial Earth was the great bugbear, and the wheel which had this for its bond was looked upon as the rising sun in the emery wheel industry. At one time the name of "Goddard" was a magic password to every saw-mill in Michigan, and Vermont knew nothing but the "Cosmopolitan." All these are now but names of the long past. It has been found out that a wheel does not necessarily grind faster because "you can blow through it," and that some close and compact wheels do better work than those of open texture. Mineral ingredients have not proved their superiority to organic matter, nor has color been identified as a distinct factor of quality.

Yet to-day the majority of factories are using solid emery wheels whose purchase has been influenced by the friendship of buyer and salesman—by the unfounded bias of some foreman, or by the unreasoning and baseless prejudice of some unintelligent grinder. In the rarest of cases can either buyer, foreman or grinder give any specific statement as to the product of any wheel or the cost of such product. Singular as it may appear, even the system of paying for grinding by the piece does not lead to a careful estimate of real value, and many buyers are found who seek the most durable wheels because their men are paid by the piece, while the men accept such wheels, not discovering that excessive durability almost always necessitates an excessively small product.

That an investigation as to real money value will pay, and that it may be made to pay both the buyer and the user, is demonstrated by the following letter of a Scottish engineering firm, dated in 1875:

"We have now had a few trials of the blank emery wheels, having used them over twelve months. The first cost being so high, and the wear so rapid, made us give them up at first, and go back to the London-made emery wheels; but our men (who do the work by piece) agreed to reduce the price so much, if we would supply them, as they said, 'with the fine kind of wheels they had last,' that the reduction does more than pay for the wheels altogether."

While the great majority of users neglect to make any inquiry as to the real money value of emery wheels, and while the few who do inquire are most unlikely to establish strict test conditions, and secure accurate comparative results, it is important to know that an inquiry of great scope is being conducted by scientific men.

It would be unwise to make known prematurely the details or results of this inquiry, but a few leading facts may be stated. These facts are the more pertinent at the present time, because the purchase of emery wheels is conducted with much less circumspection than in former years. This is true both of this country and of Europe, concerning which latter country we have heard very recent personal testimony. In both the general rule is that first cost decides the purchase; and, except in those cases where some real or fancied reason exists for adhering to some particular make, the largest discount secures the order.

A prolonged investigation has been made as to the comparative quality of fifteen different makes of American solid emery wheels. This demonstrates that under equal conditions the fastest grinder of the fifteen makes will grind off more than twelve times as much cast-iron per minute as the slowest grinder does. It does not necessarily follow that the slowest grinder is the dearest wheel of the fifteen, and the fastest grinder the cheapest; for first cost of wheel, power consumption, wear of wheels, etc., have also to be considered. But the fact does cast much doubt on the general assumption that one emery wheel is as good as another. Is it likely that a wheel which will cut only $\frac{49}{100}$ of an ounce of cast-iron per minute is as valuable a tool as that which will cut $5\frac{13}{100}$ ounces per minute? It is a singular fact that the two makes which stand thus at these opposite extremes are among the older manufactures of this industry, and almost equal in age. The ability of the one manufacturer to supply a tool whose product was calculable and great, has not interfered with the free and large sale during a long term of years of a tool whose product was disproportionately small. What are we to think of a mechanic who would knowingly stand for years over a wheel which only ground off $\frac{49}{100}$ of an ounce per minute, when he could remove $5\frac{13}{100}$ ounces in the same time? What are we to think of the manufacturer who would knowingly buy the tool which gave such small product? We are forced to believe that the great bulk of emery wheel buyers and users have no definite idea whatever as to the product of the wheel they use, nor of its real money value. Not knowing, they are misled by the two striking items of low first cost and great durability.

We are firmly convinced that nothing has cost emery wheel users so much loss as their false estimate of the money value of durability. It may be possible to get an emery wheel so friable that its rapidity of wear is not equaled by its increase of product; but this investigation seems to show that the majority of American wheels are too durable and too unproductive. The average metal removable of all the makes at a fair, ordinary working pressure was $1\frac{49}{100}$ ounces per minute, but out of fifteen makes ten fell short of this average.

While the consumption of wheel material does not bear a regular proportion to the amount of metal ground, yet, as a general rule, increased wheel consumption implies increased product. So marked is the rule that it may be safely assumed that any wheel which is notable for its durability will be a markedly slow grinder.

If we seek for an intelligible reason why the mere workman should prefer a slow-cutting wheel, we can find but one, and that is, that sometimes it appears to minister to his laziness, and afford relief from the strain of continuous work. But this is an appearance only, and a sham.

We have stated that the average metal removal per minute of the fifteen makes was $1\frac{49}{100}$ ounces, and that ten fell short of this average. This average, however, was at what we called a fair, ordinary pressure. Now, in many cases the workman is not satisfied with the small product, and to secure a greater, applies more pressure. This pressure soon exhausts him, and he then gets rest and change of work by stopping the machine and proceeding to chip or hack the face of his wheel. This investigation shows that some of the so-called very durable wheels largely increase their product if a great pressure is applied. We cite, as illustration, the case of one well-known and popular make, whose average metal removal per minute at a fair, ordinary pressure, was only $\frac{79}{100}$ of an ounce, but which, when the pressure was increased about 2½ times, attained an average of $7\frac{9}{100}$ ounces. The maximum metal removal of this wheel in any one minute was $11\frac{66}{100}$ ounces, yet in some cases its minute metal removal was absolutely nothing. The pressure which secured the average of $7\frac{9}{100}$ ounces per minute was an excessive pressure—a pressure at which some makes would be dangerous in the extreme, and which no workman could maintain. It is to obtain rest, and change from the too heavy work necessitated by extra durable wheels, that men gladly accept the job of chipping and hacking a wheel. How much time is thus lost, and how much wheel material wasted, it is impossible to say, and equally incalculable is the waste of physical effort in striving by undue pressure to exact a reasonable product from an over-hard wheel.

If wheels were provided which gave a fair product under light pressure, metal grinding by the use of solid emery wheels would not only be easier for the workman, but much more profitable. In attempting to introduce free cutting wheels, instead of the over-durable ones, one practical difficulty is frequently met. That is that the workman, habituated to excessive pressure, applies such pressure, uselessly, to the softer and freer cutting wheel, and so wears it out with unnecessary rapidity and without adequate increase of product.

It is our firm belief that the general results of this investigation show the use of too many hard wheels, and the survival in grinding processes by solid emery wheels of the same old methods which characterized British practice by grindstones. The increasing use of waterproof wheels, run wet, also tends to the use of over-hard wheels, and to careless work. The grinder thinks it easier to press his tool hard against a hard wheel, and trust to the use of water to prevent overheating, than to manipulate the tool with care against a free cutting wheel at high speed.

The object of this paper is to call the attention of proprietors and foremen to the generally uneconomical selection and use of solid emery wheels, and to point out the possibilities of great profits and losses in this process, as yet unsuspected.

The old adage about killing two birds with one stone works its perfect work in the upper part of Jersey City. Just a little under the soil is a fine bed of rock suitable for paving blocks. In building and in other operations, where excavating is necessary, blasting must be resorted to. This is costly. But the rock is broken up into building blocks and sold, and that breaks up the expense of blasting. And it gives work to men in preparing the blocks.

Phospho-boric glass for microscopes is a new kind of optical glass, which contains phosphoric acid and boracic acid, and is designed specially for the construction of object glasses. The *Photographic News* says it is asserted that by means of this new glass, lately produced in Germany, an object possessing no more than the one-eight-hundred-and-twentieth part of a millimeter can be distinctly recognized.

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Don't Discriminate.

The pending tariff bill, by one of its latest included amendments, provides that machinery for making beet sugar is hereafter to be admitted free into the United States. In our opinion this is a mistake which is liable to have very serious consequences in the future, such as machinists and everybody connected with the machinery trades, whatever their general tariff views may be, should give attention to.

Two year ago a radically different tariff bill was strenuously urged in Congress, by one of the clauses of which it was proposed to put machinery for manufacturing jute on the free list. Within the past few days, opponents of the pending tariff bill have exclaimed in Congress at the injustice of admitting beet sugar machinery free while requiring importers of cane sugar machinery to pay duties. In like manner, columns of newspaper editorials have been published in influential journals, and numberless speeches have been made at various times, strongly urging the placing of cotton machinery and woolen machinery on the customs free list. Nothing can seem much plainer than that an exception once made to the general tariff policy of the country, as to one kind of machinery, will inevitably be followed by the demand for like exceptions as to other kinds of machinery.

It is no part of our present purpose to enter upon a discussion of the tariff question, as such. Our present aim is to remind the mechanical public that machinery establishments which are making, or want to make beet sugar machinery, or any other kind of machinery, if required to use tariff-controlled materials, and to pay tariff-controlled wages, are, in equity, entitled to have a tariff protection on their products.

Our lawmakers may fix the conditions prevailing at one end of the line, as their collective wisdom and the collective judgment of the people may deem best, but, at least, similar conditions should prevail at the other end. Every consideration of justice and policy in the long run, it seems to us, calls for consistency in such matters.

But, say those to satisfy whom the amendment in question has been put in the pending bill, beet sugar machinery is not now made in this country to any appreciable extent. We think all mechanics, whether their general tariff views agree or not, will bear us out in the assertion that, when beet sugar machinery is really wanted in this country, the machinery establishments of the country will produce it, and at a reasonable cost. In like manner, to the farmers of the country, and to its varying soils, can safely be left, under equitable and judicious legislative conditions, if the reader please, the cultivation of sugar beets in substantial quantity, and having the proportion of saccharine matter required for the successful manufacture of beet sugar.

But when the machinery tariff is altered, whether to raise or lower it, the mechanics of the country should see to it that whatever changes are made should be equitable and uniform.

Self-preservation.

A press dispatch contains an account of the narrow escape of a passenger train on the New York, New Haven & Hartford Railway, from plunging into an open drawbridge.

The account says that for some reason the engineer failed to slow up at the signal, and the engine and baggage car left the track, and were stopped when only 200 feet from the open draw.

Nothing is said in this dispatch as to the cause of the engine and baggage car being derailed, but of course it is attributed to a derailing switch placed there for the express purpose of throwing the engine off the track after it had passed the danger signal.

There might have been another escape, in a similar way, in California last May, when fourteen persons were killed by a train running into an open draw, which was not provided with a derailing switch, nor even with a distance signal operated by the movement of the bridge. And this may be a good time to renew a suggestion which we first made last June, when commenting upon this accident. We then advanced the idea that organizations of railway employes could not well do a better thing than to take some measures to influence the adoption of the best safety devices for the protection of their own and passengers' lives. There is hardly a single trainman in the country who doos not know the value of automatic distance signals and derailing switches at drawbridges; and every trainman knows also what most travelers cannot know; *i. e.*, whether these means of safety are used on his road. The same is true of all other means and methods for avoiding accidents; no one, not even the officers of a road excepted, can know so well as the men employed on it just what is lacking as a means of preventing accidents, or the condition of roadway and equipment. And there can be little doubt that the publication of plain, bare facts, without comment, giving the exact condition of all roads in this respect, would attract much attention, and be a most powerful influence for reform.

Those organizations which give relief to disabled members might find that the taking of active and systematic measures to reduce accidents would prove profitable for them, to say nothing of the many other benefits which would almost certainly result from it.

There is, of course, nothing which railroad employes could do that the public would more readily see the benefit of, nor anything which would more certainly secure public sympathy and support.

No one pretends to deny that many people are needlessly killed or maimed every week on our railroads. What more effective check could there be to this needless slaughter than to have attention drawn to the causes of it, by the publication of details showing weak points discovered by men, who, in the nature of things, must be thoroughly conversant with the whole business?

The recent terribly fatal accident which occurred on the Old Colony Railroad was caused by the train striking a jack, which the trackmen had not sufficient time to remove after seeing the approaching train. The general public would know no better than to suppose this to be such an accident as could only be prevented by the trackmen being more watchful; but no sooner does the accident occur than railroad men declare that the best jack for use in track repairs does not rise above the rails, and that jacks of that kind are made and used on some roads, for the precise reason that it had been shown by experience that such jacks as are used on the Old Colony, and that do rise above the rails, would sometimes be left in position to be struck by a train, and when so struck an accident more or less serious was sure to result.

It is not to be doubted for a moment that plenty of the trainmen employed on this road knew of the danger in the use of these jacks as well before the recent accident as after it, and also knew of the means of avoiding the danger. Suppose that, through some organization of employes, the fact that these dangerous jacks were in use there, and that others could be used by which the danger would be much reduced, had been published in such a way that the public would have access to it. Are the chances not good that this wreck, with its fearful destruction of life, would have been avoided?

We will not presume to point out the details of a plan for carrying out this idea, because these can be better arranged by men within the organizations, but we think it must be evident that there is a large field of usefulness here for organizations of railroad men, and one in which they might do much to win public favor, besides greatly benefiting themselves in other ways. The old saying is that "Self-preservation is the first law of nature"; no one can blame railroad men for obeying it, especially when by so doing they may preserve others as well.

The sympathy of all true Americans is due, and will doubtless be generally accorded to our Mr. Thomas A. Edison, when it becomes known that, owing to the fact that he had promised to send to the German Emperor a phonograph, which failed to arrive on time, and allowed several letters from the Master of Ceremonies, regarding the matter, to go unanswered, it is announced, by special cable from Berlin, that should Edison ever return there *he will not be received at court*. Of course it was wrong for our Edison to disappoint the German Emperor in that way, and he probably would not have done it if he had dreamed of the possibility of being so severely punished. We shall hope that the phonograph will yet be received at court, and that it may perform so charmingly that its inventor may yet be also received there.

Education is considered a prime necessity in this country. We mean the education obtained at our common schools. There is no fault to be found with this sentiment. It is undoubtedly correct. And so much is it in accord with popular opinion that there is no serious objection to the law prevailing in many places making attendance at school, between certain ages, compulsory. But note the provisions for carrying out this law. If an attempt were made to rigidly enforce it in the city of New York, it would be found that the school-houses would not afford room to decently shelter some thousands of children between the prescribed ages. As it is, there is lack of accommodation for thousands who are desirous of attending. What is true of New York is true of a good many other cities in this country. This shows the difference between a sentiment—something to talk about—and a fixed purpose.

It is considered the proper thing to abuse the law-givers for such a state of affairs. This is, in the main, pure nonsense. The main trouble is with the people who do not believe in what they talk.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(362) J. A., St. Louis, Mo., asks: Can you give me the proportions of metal used in making Mitis castings? *A.*—No.

(363) "Subscriber," Troy, N. Y., asks: What, in your opinion, is the best form for the shank of drills for common drill-press work? *A.*—Assuming that you mean flat forged drills, we think the plain round shank is as good for these as any other form, and they may be held either in a jaw chuck or by a socket with set-screw.

(364) C. S., San Francisco, Cal., writes: I wish to build a small steam launch of about the following dimensions: Length, 25 feet; breadth, 5 feet; and depth, 4 feet. For this boat I wish to build a small compound steam engine; high-pressure cylinder, 3 inches diameter; low-pressure, 5 inches diameter; stroke of both pistons, 4 inches. Will this engine be large enough to drive the boat at a reasonable rate? *A.*—Yes. We cannot express an opinion relating to the boiler, as we do not understand your description of it.

(365) N. P., Newark, N. J., writes: I have some iron patterns which I would like to alter so that the castings from them will have indentations resembling half the inside of a hollow ball, or a hexagon shape, or something similar to relieve the plainness. The pebbled appearance sometimes seen on stoves would do. How can I fix the patterns? *A.*—We do not see how you can attain the desired end very well without making new wooden patterns of the form you want. From these you can make iron patterns.

(366) F. H., ———, writes: In nickel-plating steel it often peels or scales off, notwithstanding pains are taken in the matter of solution and current. The steel is first plated with copper. *A.*—It is impossible to say what may be the cause of the trouble in this case without a personal examination of the work and apparatus. But the cause of such trouble is usually a failure to secure absolutely clean surfaces, though for some

kinds of work it has been found that if the deposit is made too thick it is liable to cause scaling.

(367) S. & A., ———, write: We are having trouble with a lot of face cams, 10″ diameter, 1¼″ groove, ¾″ deep. We cut them from cast-iron, and find they are not durable enough. Is there any process by which they can be hardened after cutting? *A.*—In our issues of February 25, March 10, March 17, March 31, April 7, 1888, you will find some articles on the subject of hardening cast-iron by a process which has given some very good results. It consists simply in heating the piece to a cherry-red, applying potash and dipping into water.

(368) O. M., Troy, N. Y., asks: Will you please give a rule for the crown of belt pulleys? *A.*—A rule given by Cromwell, where pulleys are rounded, is to make the crown equal $\frac{1}{20}$ the width of the belt; or in other words, the diameter of the pulley at the center equals that at the sides, plus one-tenth the width of the belt. Where the pulleys are not rounded, but simply made higher in the center with straight lines joining the sides and center, this amount may be reduced to one-half that given. There is no hard and fast rule for this, however, for the crown of a pulley is in the nature of a compromise, and is largely a matter of judgment.

(369) E. W. W., Jersey City, writes: We use in our factory machinery and tool steel in sheets and plates which we punch, mill and file, and have great trouble in keeping the tools sharp on account of the scale. In punching it we try to grind it off, but on account of the width we do not make a very satisfactory job. Do you know of any acid solution that will remove it, and how it is treated? Also how is rust prevented? *A.*—The scale may be removed by pickling in a bath of water containing a little sulphuric acid. This will loosen the scale, and it can then be removed by brushing with a little sand and a stiff brush with water. After washing, it may be dried in sawdust, but if troubled by rust it may be prevented by applying grease.

(370) W. B., Cleveland, Ohio, writes: Please recommend a good book which treats on valve motions, and the smooth running of the steam engine. *A.*—Slide Valve Gears, by F. A. Halsey, we believe to be a good book on valve motions. For the smooth running of engine, see articles on this subject by Prof. Torrey, published in the AMERICAN MACHINIST. 2. What compression is needed in a pump so as to prevent pounding when running wild? Please give rule for computing the same. *A.*—No rule can be given for computing the compression. Experience and good judgment in designing and fitting up the pump is required. 3. What is the proper speed for pumps? *A.*—The speed of pump pistons varies according to circumstances and the class of liquid pumped. Ordinary direct-acting steam pumps run at from 100 to 125 feet per minute.

(371) R. S., Brooklyn, N. Y., writes: Please inform me what is meant by the b and h^3 and $(h^3 - h_1{}^3)$ on page 9 of your issue of August 28th. Also what is meant by $P = \frac{W}{t}$, and other symbols on page 11 in the same issue. *A.*—The symbol b on page 9 denotes the breadth of the section shown in Fig. 2. The symbol h denotes the outer height, and h_1 the inner height of the same section; h^3 means the cube of outer height; and $h_1{}^3$ the cube of the inner height; hence, the expression $h^3 - h_1{}^3$ reads: From the cube of the outer height subtract the cube of the inner height. By reading carefully the article on page 11 you will readily understand the meaning of the symbols in the formula $P = \frac{W}{t}$. If you have any difficulty in reading the signs, we must refer you to any good arithmetic. After you can read these formulas, you will prefer them to rules written in the ordinary language, as the former are far more convenient to use than the latter.

(372) L. P. S., Conshohocken, Penn., writes: I would like to know the best way to carry steam from a 40 horse-power boiler 225 feet away to a 4 horse-power engine. The pipe starts from the top of boiler four feet in a horizontal direction, then ten feet downwards. From the latter point it runs underground through a distance of 200 feet, and then upwards through a distance of 16 feet to the engine. What size pipe would you use, and how would you cover it? My idea is to use a ¾-inch pipe covered with a wooden conduit painted with gas-tar. Or would it be advisable to start with a 2 inch pipe and end up with a ¾-inch pipe? *A.*—The term "four horse-power engine" is very indefinite for the purpose of computing the diameter of the steam pipe, as this diameter will depend on the diameter of cylinder, piston speed and steam pressure. On general principles we should use a pipe one inch inside diameter covered with one half inch thick felt and spun yarn; and under ground run it through a wooden conduit as you propose.

(373) A. B., New Haven, Conn., asks: Will you inform me why the cutter used in cutting spiral mills (40° on one side and 12° on the other) is especially adapted to that work? Why would not a cutter with a greater or less angle do as well, and where can I get information in regard to cutting spirals on a milling machine, and the formation of cutters for the same? *A.*—We suppose that the angle of 12° was chosen because that angle gives a radial face to the front of the tooth when the cutter is set over from the center a distance practically equal to one-tenth of the diameter of the cutter at the bottom of the teeth. The angle of 40° for the other side was chosen because it gives what is believed to be a good form of tooth. Other angles than 12° would of course do, and in fact are sometimes used, but that is enough angle to give a good clearance, and the distance to set over from the center is easily calculated and measured. The only information published in regard to the matter, so far as we are aware, will be found in a book on the Milling Machine, published by the Brown & Sharpe Mfg. Co.

(374) C. W. B., Columbia, Pa., writes: Kindly inform me what amount of coal it should take to generate 30, 40, 50 and 60 pounds of steam in a 60 horse-power horizontal boiler with two 12-inch flues? *A.*—If the boiler is properly set, you may evaporate 9 pounds of water per pound of coal. Under these conditions it will require $\frac{30}{9} = 3.33$ pounds of coal to generate 30 pounds of steam; or $\frac{40}{9} = 4.44$ pounds of coal to generate 40 pounds of steam. In a similar way you may find the amount of coal for any other quantity of steam. 2. What is the most economical pressure to carry for a 40 horse-power engine? *A.*—That will depend on the size of the cylinder, and other conditions. 3. What is the average (or a fair) price, or cost of a horse-power? *A.*—Since the price of coal varies in different localities, the cost of a horse-power will also vary; the size and kind of engine will also affect the cost. Very small engines will use from 8 to 10 pounds of coal per horse-power per hour, ordinary non-condensing engines will require from 3 to 5 pounds of coal per horse-power, and large condensing triple expansion engines have been run with 1½ pounds of coal per horse-power per hour.

(375) W. E. P., Brooklyn, N. Y., asks: 1. What are the angles at the face and bottom of the teeth of a pair of bevel gears 6 pitch, one gear having 20 teeth, the other 30? *A.*—The angle between the center line of the larger gear and the top of the teeth, or what is called the face angle, will be 59.5°. The same angle on the smaller gear will be 36.9°. The angle at the bottom of the teeth of the larger gear will be 52.8°, smaller gear 30.2°. 2. Would the angles equal the same as a pair of bevel gears both of the same diameter? *A.*—No. 3. Do the angles always equal 90° at face and bottom of teeth when the shafts are at right angles to each other? *A.* No; they never do. When the gears are the same size, and the shafts at right angles, the total angle from one side of the pitch cone to the other is 90°, or, in other words, the center angle is 45°. At the top of the teeth it is greater and at the bottom less. 4. Is the outside diameter of a bevel gear, 4 pitch, 24 teeth, the same as a spur gear 4 pitch, 24 teeth? *A.*—No. 5. What does Wendell Willis mean by a "button," in his article on jig making? I have seen a great many jigs made, but have never seen anything of the kind used. *A.*—He means simply a small cylinder or collar of steel with end ground very true with the outer surface. A screw is passed through this button into the body of the jig about where the hole is to be bored, and when the button is located just where the hole is to be, the screw is tightened up to hold it there, and the jig so mounted in the lathe as to center the button exactly, using an indicator for the purpose. After it is centered the button is removed and the hole bored in the usual way.

(376) J. W. S. J., Cincinnati, Ohio, writes: I find in a hand-book of land and marine engines a list of factors given for the purpose of computing the horse-power of engines—for instance:

Diam. of cyl. in inches.	Factors.
8	.152
10	.238
12	.342
14	.446

The rule given for finding the horse-power of an engine is: Multiply the factor of the given diameter of cylinder by the speed of piston in feet per minute, and multiply this product by the average steam pressure in pounds per square inch; this last product will be the horse-power. Now what I wish to know is, how are the factors in the table obtained? *A.*—The factors in the table are not correct. They are found by dividing the area in square inches of the cylinder by 33,000. Thus the area of an 8-inch cylinder is 50.265 square inches, and dividing this area by 33,000, we have

$$\frac{50.265}{33{,}000} = .00152.$$

Hence, the factor should have been .00152, instead of .152. In a similar way you may find the factors for the other cylinders. For instance, the area of a 14 inch cylinder is 153.94 square inches, hence the required factor will be

$$\frac{153.94}{33{,}000} = .00466,$$

instead of .446.

(377) G. F. S., Glen Rock, Pa., writes: You would oblige me by giving the names and addresses of the best universities that teach mechanical drawing. Would you advise me to take the course? I am 26 years of age, and have saved enough working as a machinist to take the course, I suppose. Do graduates generally find positions, and are they fit to fill the same? *A.*—It is impossible for us to say which are the best schools for this, but all those which teach mechanical engineering of course teach drawing also. There are a great many of them, so many that we cannot undertake to name them all, but some, the names of which occur to us at this time, are: Cornell University, Ithaca, N. Y.; Lehigh University, Bethlehem, Pa.; Massachusetts Institute of Technology, Boston, Mass.; Ohio University, Columbus, Ohio; Stevens Institute of Technology, Hoboken, N. J.; Troy Polytechnic Institute, Troy, N. Y.; University of Illinois, Champaign, Ill.; University of Virginia, Charlottesville, Va.; University of Wisconsin, Madison, Wis.; Worcester Polytechnic Institute, Worcester, Mass. As a general thing we do not think it is advisable for one who is as old as you to take a course in mechanical engineering unless that has been the intention from the first, and it has only been postponed for some special reason. As a general thing, when a machinist has arrived at that age he will have acquired considerable knowledge of engineering if his inclination has been that way, and we think it better for him to pursue his studies of the business in connection with his work. Drafting can be studied in an evening class or with a teacher employed for the purpose. Some men might be benefited by the school at that age, but the majority, we think, would not be. Graduates generally get positions of some kinds, but the position secured and held depends more upon individual capacity than upon the mere fact that one has graduated.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book, mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Milling Machines. Pedrick & Ayer, Philadelphia Pa.

Universal Grinding Machine. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

One Star Hack Saw will do as much work as five of any other kind.—N. B.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Sept. 11, p. 18. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N.Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

"Roper's Hand-Books," for engineers and firemen. Send for descriptive catalogue. Address Edward Meeks, publisher, Philadelphia, Pa.

Billings & Spencer Co.'s Packer & Boiler Ratchet, & all kinds of Forged Wrenches. S. A. Smith, 23 S. Canal st., Chicago, Western representative.

25″ Upright Drills a specialty. Finely made,
28″ great capacity, quickly operated, prices low.
32″ Send for list of firms using our Drills. J. E.
36″ Snyder, Worcester, Mass.

25″ } "Only Drill Press built on
32″ } 'Ko-rekt' principles,
37″ } even if they come from Jersey."
42″ } Gould & Eberhardt, Newark, N. J.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting
Rods for small connections.
Especially adapted for Valve
Rod for Steam Engines.
T. C. Dill Machine Co.,
Philadelphia, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES.

A cotton-gin and grist-mill will be erected at Sardis, Tex.

A cotton factory will, it is rumored, be erected at Waxahachie, Tex.

A stock company will erect a cotton-seed oil-mill at Abilene, Tex.

It is stated that an electric light plant will be erected at Beeville, Tex.

The Batesville Iron Works, Batesville, Ala., will add a foundry to its machine shops.

Liddell & Co. are about to build a large machine shop and foundry at Charlotte, S. C.

Ground has been broken for the Sheffield (Ala.) Foundry, Machine and Boiler Works.

The Kingsbury Manufacturing Company is erecting a machine shop at Beresford, Fla.

A stock company is reported as organized, to erect an ice factory at Atlanta, Texas.

Beard & Son, Greenville, S. C., will build a foundry and machine shop at Spartanburg, S. C.

A movement is on foot at Parkersburg, W. Va., looking to the establishment of a nail factory.

The handle factory of Hartwell Brothers is to be removed from Delphos, Ohio, to Paducah, Ky.

The Jackson Foundry Association will erect a new building for its iron foundry at Jackson, Tenn.

A stock company, with a capital of $100,000, has been formed to erect a paper-mill at Sunapee, N. H.

It is stated that the Lawrence Iron Works, of Ironton, O., will move its rolling-mill to Glasgow, Va.

A syndicate has purchased the Cummings Iron Works at Hammond, Ind., and will increase the plant.

The establishment of a co-operative iron foundry and machine shop at Durham, N. C., is contemplated.

Pottery works are to be established at Augusta, Ga. The plant will cost between $30,000 and $40,000.

A company is being organized at Belton, Texas, for the purpose of erecting a 5,000-spindle cotton factory.

It is stated that the Lawrence Iron Works, of Ironton, Ohio, will move their rolling-mill to Glasgow, Va.

Work is being pushed rapidly on the new lumber-mill at Orange, Tex., and it will soon be in operation.

The Cate Lumber, Brick and Improvement Company is erecting a new saw-mill 40x150 feet at Hammond, La.

A stock company has been formed at Lafayette, Ind., to start another sash, door and blind factory in that city.

J. A. George has prepared plans for a three-story machine shop 60x100 feet and a foundry 30x50 feet at Rome, Ga.

The foundations are being laid for the new Kimball carriage factory that will be erected at Manchester, N. H.

A steel plant is to be erected at Ironton, Ohio, by the Belfort Iron Company and the Kelley Nail and Iron Company.

The Newport (Va.) Iron and Steel Works have been sold to a syndicate. The plant will be enlarged and improved.

The new town of Piedmont, Ala., expects to have its foundry and machine shops in full operation by the end of the month.

It is stated that an iron furnace will be built, and an iron foundry and machine shop established at Crawfish Springs, Ga.

A rolling-mill for the manufacture of merchant bar iron from scrap is being built at Fort Worth Tarrant County, Texas.

The De Leach Manufacturing Company, of Atlanta, Ga., are building a new foundry and machine shop, 400x70 feet.

The Youngstown Iron and Steel Company, of Youngstown, Ohio, has been incorporated, with a capital stock of $600,000.

The North Chattanooga Manufacturing Co. will erect works for the manufacture of mill machinery in North Chattanooga, Tenn.

The Eureka Mill Company is the name of the stock company recently organized to erect a roller flour-mill at Gibonsville, N. C.

James W. Hull, of Pittsfield, Mass., has bought for $15,000 a large tract of land, on which it is proposed to erect a manufacturing plant.

It is reported that an 8,000-spindle cotton factory will be erected at Albertville, Ala. The Albertville Land Company can give information.

The North Chattanooga Manufacturing Company will erect works for the manufacture of mill machinery in North Chattanooga, Tenn.

The Duval Engine Works, of Zanesville, Ohio, are reported to be about to move to Sherman, Texas, where they will establish a new plant.

Machinery has just arrived for a twenty-five-ton ice factory at Tyler, Tex., to be put in operation immediately by Messrs. Simon & Brown.

A new plant for the manufacture of iron piping is to be erected at Bessemer, Ala., by the Howard Harrison Iron Co., capital half a million.

The Greenville Ice and Storage Company, with a capital stock of $14,000, is reported as organized, to erect an ice factory at Greenville, Ala.

A company has been formed at Parkersburg, W. Va., for the purpose of making the Hastings steel wire nail, also for building the machines.

The Satsuma Lumber Company, of Satsuma, Fla., will put in shingle machinery, with capacity for about twelve or fifteen thousand per day.

The Cummings Iron Works, at Hammond, Ind., have been purchased by a syndicate, who, it is said, will increase the plant and employ 500 hands.

The W. E. Moffatt Manufacturing Company will add an iron foundry to its plant at Chester, S. C., and increase its machinery and business in all departments.

The Lookout Boiler Works at Chattanooga, Tenn., have purchased additional space, and are now enlarging their plant and adding much new machinery.

The Dallas (Tex.) Ice Factory will put in during the fall and winter a fifty-ton ice machine, increasing its capacity to 140 tons per day; also an electric light plant.

Capitalists interested in the Norfolk & Western Railroad will build the large steel plant projected at Lambert's Point, Va. The site is said to have been selected.

A company, with a capital of $20,000, has been organized at Nashua, N. H., for the manufacture of hardware, and will give employment to a large number of hands.

The work on Poole's new carpenter shop and planing-mill near the depot is progressing. Piles have already been driven in the ground and posts placed upon them.

The Cuero Cotton Seed Oil and Manufacturing Company, $25,000 capital, and the Greenville Compressing and Manufacturing Company, $50,000 capital, have been chartered.

The company operating the New Cumberland (W. Va.) Foundry and Machine Shops contemplate increasing its capacity by erecting a new building and putting in new machinery.

The Ellis & Lessing Steel and Iron Co., of Pottstown, Pa., are enlarging their works by the erection of a new building, and adding two more puddling furnaces, making twenty-two in all.

The Harvey Steel Car Company, of Chicago, have begun the erection of their buildings at Harvey, a new manufacturing suburb, and they hope to begin the manufacture of cars by October 1.

The Porter Foundry and Machine Company, of Allegheny, Pa., will rebuild their shops, recently destroyed by fire. Two new wings, 60x90 and 60x70 feet respectively will also be added.

The H. Dudley Coleman Machinery Company has been incorporated at New Orleans, La., to succeed H. Dudley Coleman & Co., manufacturers of machinery, etc. The capital stock is $100,000.

The Fuller & Johnson Manufacturing Company, of Madison, Wis., will remove its plant to Milwaukee. This company manufactures farm implements and machinery, and employs 300 men.

It is stated that the Nashville, Chattanooga & St. Louis Railroad Company (office, Nashville, Tenn.), and the Alabama Mineral Railroad, will erect joint machine shops and roundhouses at Attalla, Ala.

The Basic City (Va.) Car Works Company is erecting machine shops and foundry, 60x100, planing, tongue and grooving-mills, 60x100 feet each, erecting shop, 60x143 feet, and paint shop, 17x143 feet.

A charter has been granted to the Burton Machine Co., of Erie, Pa., with a capital of $12,000. The directors are: Andrew Burton, J. W. Boomell, F. C. Burton and Wilmington Bowming, all of Erie.

The Connecticut Motor Company (Plantsville, Conn.) has issued a very neat catalogue of electric motors. The catalogue sets forth the advantages of electric motors, the illustrations being excellent.

The Western Furnace Company is progressing rapidly with the construction of its plant at Manistique, Mich. The foundations are about completed, and it is expected to go into blast before January 1, 1891.

The Graham Land and Improvement Co. has, it is stated, closed contract with the C. P. McWane Plow and Foundry Co., of Wytheville, for the removal of its iron foundry and plow works to Graham, Va.

The Wheeler Manufacturing Company, Chicago, has been incorporated, to manufacture architectural iron, brass and bronze work; capital, $12,000; incorporators, E. L. Wheeler, E. E. Wheeler and A. J. Mostchman.

The Eaton & Prince Company, Chicago, has been incorporated, to manufacture elevators, and do a general machine shop business; capital, $125,000; incorporators, Thomas W. Eaton, F. H. Prince, James M. Walker.

It is said that contracts have been signed for the erection of a rolling-mill, iron furnace, foundry and machine shops, and other industries, at Kensington, Ga. Negotiations are also said to be pending for pipe works.

C. D. Farrar and A. H. Foster, of Union; C. E. Fleming, of Spartanburg, and others, have incorporated the Lockhart Manufacturing Co. to erect a cotton factory at Lockhart Shoals, S. C. The capital stock is $500,000.

The Ellis & Lessig Steel and Iron Company, of Pottstown, Pa., has commenced the erection of a new building to enlarge its puddling department. Two more furnaces will be added to the mill, making twenty-two in all.

The Lockhart Shoals Construction Company has been incorporated at Chester, S. C., by Wade Osborne, R. O. Thompson and Joseph M. Sims. The company is organized to construct railroads, build canals, erect mills, etc.

It is said that contracts have been signed for the erection of a rolling-mill, iron furnace, foundry and machine shops, and other industries, at Kensington, Ga. Negotiations are also said to be pending for pipe works.

A company, to be known as the Emerson Car Co., has been incorporated at Charleston, S. C., for the purpose of manufacturing A. S. Emerson's ventilating apparatus for railway cars. The capital stock is placed at $300,000.

The oil-mill project of Caldwell, Burleson County, Tex., has grown into a reality. The machinery has been ordered and is being rapidly set in place. The mill will be ready for work about October 1, and will cost about $7,000.

The American Fiber Company, with C. H. Adams, president; J. J. Barr, vice-president, and J. C. Donavin, secretary, has been incorporated, to manufacture defibrating machinery, at New Orleans, La. The capital stock is $350,000.

The Frederick County Hygeia Ice Co. has been incorporated with C. V. S. Levy, president; J. L. Nicodemus, vice-president, and D. H. Hargett, secretary, to erect a 20-ton ice factory at Frederick, Md. The capital stock is $21,000.

The Ashley Wire Company, Joliet, Ill., is putting in the foundations for a main building 195x278 feet in size, to be built of stone, brick and iron, and a warehouse 100x100 feet. It is expected that the mill will be in operation by November 1.

The Lockhart Iron and Steel Company has closed down its mill at Chartiers, Pa., to make additions and repairs. Twelve new puddling furnaces will be built, and the muck rolls will be changed from two-high, as at present, to a three-high mill.

The Coleman Rolling-mill Co. has been incorporated, with a capital stock of $85,000, to build a rolling-mill at South Pittsburgh, Tenn. The mill will have a capacity of thirty tons of iron per day. Barry Coleman, of St. Louis, Mo., is president.

The National Railroad Forging Machine Company, with $200,000 capital stock, has been incorporated at Covington, Ky., to manufacture railroad forgings. The incorporators are J. S. Pessinger, of Brooklyn, N. Y., and H. M. Lewis, of Cincinnati.

The foundation has been completed for the building of the Steel Truss Car Wheel Works, Edwardsville, Ill. The contract provides that the entire structure shall be completed by November 1st. Part of the machinery for the plant has already arrived.

The Cumberland Manufacturing Company has been organized at Harriman, S. C., with Frederick Yates, president; Ferdinand Schumacher, vice-president, and R. W. Gates, secretary, to erect a sash, door and blind factory. The capital stock is $500,000.

T. H. Nevin & Co., the paint manufacturers of Allegheny, Pa., will erect a new plant on Island avenue as soon as the builders can get to work. The new building will be three stories high, perfectly fireproof, and when completed will cost about $80,000.

The Harris-Weaver Building and Manufacturing Company has been organized, at Johnson City, S. C., with C. H. Lyle, president; C. N. Brown, vice-president, and C. P. Pence, secretary. It has purchased the Frank Evans planing-mill property and will operate same.

The Swift Iron and Steel Works, of Newport, Ky., formerly owned by E. L. Harper, of the defunct Fidelity Bank, has been bought by the Ironton Steel Works Company, and will be rebuilt and enlarged, it is reported, until it will be one of the largest steel works.

The Duthie Engine and Machine Shops, of Knoxville, Tenn., will be moved to Harriman, Tenn., and operated by the Duthie Machine and Foundry Co., which has been incorporated by G. H. Duthie, F. W. Sanders, W. C. Harriman and others, with a capital stock of $20,000.

A muck and bar-mill is to be established in Roanoke, Va., in the near future. There will be thirty puddling and heating furnaces, which will give employment to from 300 to 400 men, and work will be immediately begun upon the plant, which is to cost $500,000, and will be one of the largest iron industries in the South.

A number of local capitalists, headed by Mr. J. H. Ricketson, have organized a company for the manufacture of tin sheet and tinned plate plants complete. Negotiations are pending, and an option has been secured on the Pollock farm, above McKeesport, for a site for the proposed plant. The capital is $50,000.

It is reported that the Shenandoah Furnace Co., D. W. Flickwir, president, will build an extensive rolling-mill plant at Shenandoah, Va. Frank C. Roberts, C. E., Philadelphia and Pittsburgh, has been engaged by the company as engineer, and will have entire charge of the work, both in its design and construction.

The Ashland Steel Company has been formed by the Belfont Iron Works Company, and the Kelley Nail and Iron Works, of Ironton, Ohio, and the Norton Iron Works, of Ashland, to build a steel plant at Ashland, Ky. The capacity is to be 300 tons of finished steel per day, and the plant is estimated to cost from $400,000 to $500,000.

The Iroquois Furnace Company has taken out a building permit for the erection of a blast furnace at South Chicago, Ill. The members of the company are Youngstown and Pittsburgh capitalists. The leading spirit is S. Frank Engle, of Youngstown. Plans have been prepared for one furnace, but it is expected that others will be added in due time.

The track bolt works of the Springfield Iron Company, Springfield, Illinois, which were destroyed by fire July last, have just been rebuilt, and have resumed operations. The company have taken advantage of rebuilding the works to remodel them in every particular, and now have probably the best facilities in the West for the manufacture of track bolts.

The Gas, Heat and Power Co., Westfield, Mass., has been organized, with a capital stock of $500,000, to manufacture machines and build retorts for the production of illuminating gas from crude petroleum, for lighting, heating and power. The corporation is chartered under Maine laws. A. D. Warren, of Worcester, is president, and W. P. Warren, of Westfield, treasurer.

Work on the Hopkins Rolling-mill at Slatington, Pa., is progressing rapidly. The foundation for the engines, boilers, furnaces, puddle trains and squeezers have been completed, and work on the superstructure has already been begun. Five boilers and a large amount of other machinery have been received, and it is probable that the mill will go in operation by October.

The extensive steel plant which is to be erected at Jacksonville, Ala., will cover twenty acres of ground, and when all departments of the plant are in full operation it will give employment to more than 3,000 people. Steel is not alone to be manufactured. The entire product of the great enterprise will be converted into plows, hoes, hammers, hatchets, and similar implements.

The Kings County (Long Island, N. Y.) Gas and Illuminating Company has organized, placed its capital stock at $100,000, and purchased a plot of ground on Fort Hamilton avenue, Brooklyn, prior to the commencement of active operations. The string of villages, settlements and residences extending along Bay Ridge and Bath back to Gravesend will be supplied by the company.

The Clinton Fire Brick Works has been organized in Ashland, Ky., with an authorized capital of $50,000. Work will be commenced at once in the erection of buildings, and it is expected that the plant will be in operation by the first of February, 1891. The officers are: E. C. Means, president; D. A. Leffingwell, superintendent, and R. C. Richardson, secretary. Fire clay from Boyd and Carter Counties, Ky., will be used.

The business of the old and well-known firm of New York Central Iron Works (W. B. Dunning, proprietor), has grown to such proportions that it has been thought best to form a stock company. The New York Central Iron Works Company, of which he has been chosen president, succeeds the former firm. More than 15,000 Dunning boilers are now in use, supplying steam heat to residences, business and public buildings, places of worship, etc.

The Hercules Iron Works, of Chicago, Ill., have completed the erection of their buildings at Aurora, Ill., and will soon have the machinery in place. The buildings are very substantial structures, composed of brick and stone, and comprise a machine shop, foundry and office. They are located along the tracks of the Chicago, Burlington & Quincy Railroad, near the stove foundry of Rathbone, Sard & Co. The products of these works are steam engines, ice machines, etc.

Several Pittsburgh capitalists are interested in a company recently organized in Chicago with a capital stock of $5,000,000 for the purpose of manufacturing structural iron. The site has as yet not been chosen, but lies between the selection of a location at Stickney, and one in South Chicago. The leaders in the enterprise are Messrs. Parkes & York, Phœnix building, Chicago. This is the same firm which erected the large furnace at Ashland, Wis. The company when in operation will employ about 1,500 men.

Ground will be broken in a few days for the Madison Car Works, at the foot of the Merchants' Bridge approach, St. Louis, Mo. The company has a capital of $500,000 fully paid, and it is expected that the works will be in operation by January. These works will give employment to 1,000 men, and it is proposed to turn out twenty passenger and freight cars a day. A model town will be built up for the employes, on the pattern of Pullman, Ill., and the movement will stimulate the building of other car works at this center.

There is water-works agitation in Middlebury, Vt.; Winchester, Tenn.; Marysville, Kan.; Port Angeles, Wash.; Weldon, N. C.; Coldwater, Mich.; Columbia, S. C.; Lake Forest, Ill.; Mt. Vernon, Ind.; Arkadelphia, Ark.; Louisville, Ky.; San Diego, Cal.; Greenville, S. C.; Church Hill, Pa.; Steelton, Pa.; Emerson, Ga.; Comanche, Tex.; Elma, Wash.; Quanah, Tex.; Boston, Ga.; Cheyenne, Wyo.; Leeds, Iowa; New Britain, Conn.; Buchanan, Mich.; Newmanstown, Pa.; Independence, Kan.; Toronton, Ont.; Meriden, Conn.; Water Valley, Miss.; Belmont, N. Y.; Knoxville, Tenn.; Montrose, N. Y.; Humboldt, Iowa; Rochester, N. Y.; Ft. Smith, Ark.; Ashland, Ky.; Griffin, Ga.; Madison Ga.

Negotiations are said to be in progress and practically completed, by which the entire steel plant of the Harper-Swift Company, located in one of the suburbs of Cincinnati, Ohio, will be transferred to Duluth, Minn. In Cincinnati the plant occupies fifteen acres of space, and twenty acres have been set apart in close proximity to West Duluth. One thousand men will be required for day work and 500 for the night shift. The cost of the entire plant will be $1,000,000. The proprietors of the enterprise are Messrs Joseph Sellwood, E. L. Emery, E. C. Gridley, F. C. Bowman, A. M. Stearns, M. Douglass, of Duluth, and W. C. Stearns, of Chicago. The company controlling the steel plant will be entirely reorganized, with new men and larger capital. The principal business of the company will be the manufacture of structural steel and iron shapes and the rolling of bars, plates and merchant steel shapes.

The St. Louis Iron and Machine Works' new brick structure, together with needed additional machinery and repairs in their old shops, will cost about $100,000. The motive power to be used in their new machine shop will be supplied by two large Corliss engines. As in their new foundry, a large traveling crane will run the whole length of the shop, thus enabling them to handle the largest casting with comparative ease. The work of construction is being rapidly pushed and is nearing completion. Their recently built foundry has all the modern improvements which facilitate work. After the new addition is completed for the machine and erecting shop the old machine shop will be used as a warehouse. The new building, as previously reported in these publications, will be 225x80 feet and one story high, with an interior gallery. When all improvements are finished the works will have a frontage of 500 feet on Chouteau avenue and a depth of 125 feet on Main street.—*Age of Steel.*

Messrs. R. R. & F. W. Britton, formerly of the Britton Iron and Steel Company, Cleveland, Ohio, will at once begin the construction of extensive steel works adjoining the Baackes Wire Nail Company's works, on the Lake Shore road. Property to the extent of 10¾ acres has been purchased, and ground will be broken immediately. Two tracks will be laid at once, which will, when the buildings are constructed, run on one side, and through the middle of the main structure. The dimensions of the main building will be 130x160 feet, one story, and covered with iron. In this building will be placed a plate-mill, a bar-mill for rolling sheet bar, and a sheet-mill for rolling light sheets. The machinery will be operated by a Reynolds-Corliss engine of 1,200 horse-power. In the next building, which will be 100x150 feet, there will be a 1,000 horse-power Corliss engine, operating an 18-inch bar train. Early in the spring there will be added an open hearth steel works plant for the purpose of making steel for the consumption of the company. Galvanizing iron works will also be put up in the spring. It is expected that the plant will be ready for occupancy by Nov. 1, at which time about 150 men will be employed.

The Modern Steam Plant and its Management.

BY PETER H. BULLOCK.

THE TRANSMISSION OF POWER.

It is often the case in the production of energy that the various processes between the coal-pile and the revolving fly-wheel receive full and careful attention, while the transmission of the energy beyond that point is faulty, both from original design and subsequent neglect. This is more often so where the engineer's authority ceases, when the power has been produced, and the transmission and utilization of it is left to other persons, whose mechanical skill is often very limited, and whose time and energies are fully taken up with manufacturing technicalities or commercial problems. There are plenty of places where they can tell you the exact amount of fuel used, and the cost of a horse-power per hour, but they could not give you an intelligent guess as to how much of that power is delivered at the producing machines, or turned into useful work.

It is not my intention to dwell upon only the most common methods of transmitting power, such as by belts, gears and shafting, as they are usually found in manufacturing establishments, believing that other methods, such as by compressed air, water pressure and electricity, need only be used under special conditions, and when adopted it should be under competent advice and the apparatus carefully erected.

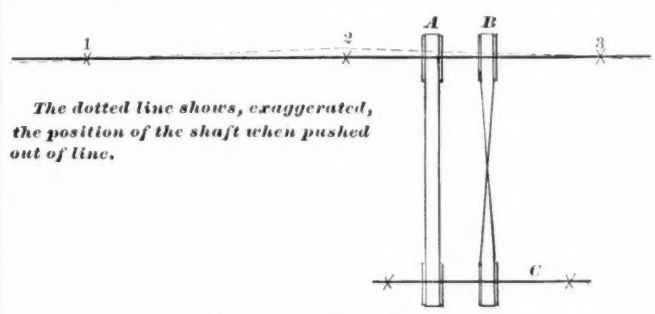
It is not to be expected that all the power developed by the engine, or other prime mover, can be utilized for the manufacture of goods, but it should all be utilized for useful work. By this is meant that it is necessary to transmit power to the points where it is to be used, and that there is no known method of transmission that does not consume some power, therefore as it is necessary to transmit the power, and that loss by so doing is unavoidable, such work becomes useful from the fact that it is a necessary preliminary to the energy consumed in the actual production of goods. In this article I will attempt to show how much unnecessary loss there is in transmitting power where the means employed are not properly designed or cared for.

An engine might indicate 300 horse-power, and all this energy be delivered through a belt from the fly-wheel to the main shaft, and, if the belt was of suitable size and in good condition, all of the 300 horse-power would be transmitted to the shaft, except what power is consumed in bending and straightening the belt in four places, and the friction of it in passing over the pulleys and through the air. Now we have a revolving shaft transmitting the power in a line at right angles to the run of the belt, and if the shaft is properly erected and in good condition, it should deliver at its other end all the power it receives, except that which is consumed by the friction of the bearings and the friction of the shaft and its attachments from revolving in the air. I may be told that this is exactly what does occur, which we will admit, and try and show what some of the conditions are that will be necessary in order that the percentage of loss may be reduced to the minimum:

For belts, it will be necessary that they have contact surface enough so that they will do the work at a reasonable tension without slipping, but not tight enough to make excessive strains on the bearings, and that they are not too wide for the work to be done, thereby increasing the weight and air friction. The necessary conditions for good running shafting are that the lengths shall be round and straight; that the couplings bring the lengths together correctly; that the bearings are properly fitted, and that it be erected firmly, in line, and level. Let us see why these conditions are necessary in order to transmit power economically, taking the case of belts first.

The width of a belt is a matter of original design, while its tension is a matter of care; but the latter may be wrong in either direction from a mistake in the former, as, for instance, where the belt is too narrow or has too little contact surface by being used on too small a pulley, and has to be kept too tight in order to do the work, or where it is too wide, and it is neglected partly from the fact that it will do its work without slipping, even if it is so slack that it creates a regular tornado with its undulations while running. If a belt slips the losses are several. First, there is a certain amount of forward energy expended by the prime mover that has had no useful result at the producing machines; second, there is a rapid wear to the belt, due to the sliding motion over the surface of the pulley, and there is a loss of speed from the established standard. These results obtain where the belt is as tight as it should be, but having too little contact surface for doing the required work. If the belt is wider than necessary it may be run too loose and still not slip, but it will be likely to run in swells that consume more power than most people imagine. This is especially apt to be the case at high speeds and where the work is uneven. If you want to see how much power is lost by such "flopping," attach a spring balance to the belt when still, and with your hand as motive power, "flop" it for about a minute, and see how much the balance registers as a result of your exertions. Belt stuffing of a sticky nature may give temporary relief from a slipping belt, but there is a loss of power from the resistance to leaving the pulleys on the delivery sides, and the belt also becomes coated with dust adhering to the sticky surface, which prevents a good contact with the pulleys, it now being generally admitted that the best results obtain where the pulleys are smooth and clean, and the belt clear and pliable, but not too oily.

Referring to the conditions that must exist in order that shafting may be run with the least possible power, we find that in theory it matters not whether the shaft in question be a single length, with two or more bearings, or a line of indefinite length, so long as the original conditions of being straight, level and in line are maintained, and the same proportion of bearings are provided. But in practice it is often found that while each length may be straight, that, owing to some inaccuracy in the couplings, the line, when coupled up, has the appearance of being crooked, one error at a coupling often transmitting its "wabble" to the line for several feet each side of the coupling where the error exists. When this is the case the only correct remedy is to remove the cause; if the coupling is flanged and bolted, it should be faced up, *after* being keyed to the shaft. If this is impossible or impracticable, you can loosen the bolts, and by turning the shaft slowly it will be seen where the joint opens the most, and a thin piece of metal can be inserted and the bolts tightened up again. You may not be able to get the shaft to run perfect, but it can be wonderfully improved. If shaft couplings are not true, it makes a crook in the line at that point; if the bearings are in line and rigid, it results in there being a constant springing taking place in four places, two each side of the crook, the same as if a single length was bent, or a single bearing was out of line and the shaft was straight. This is exactly opposite to a crank, for that consists of four bends, the opposite ones being equal, bringing the continuation into the original line, and these might be introduced between every bearing, and if they were perfect they would have no effect on the *line* of the shaft, and no effect on the power consumed in running it, except the increased air friction, which, of course, would be considerable. A shaft that is crooked, and is run in bearings that are in line, consumes power equal to the amount of strain it requires to spring it into line, and this strain is constant in any position that the shaft may be in, but as it revolves it shifts the strain to the bearing, and has a tendency to wear and loosen it. If the shaft is straight, and the bearings are out of line or level, the result is similar as to the constant strain of bending the shaft as it revolves, but the strain on the bearing will be one way all the time, and the tendency will be to wear the bearing in a direction that will allow the shaft to straighten itself. If a shaft is crooked, and the bearings are out of line to the same amount, there will be one point in each revolution where there will be no strain, but opposite to that will be a point where it will be double, and the result will be a jerky motion, worse than if one or the other was right.



The dotted line shows, exaggerated, the position of the shaft when pushed out of line.

MODERN STEAM PLANT.

In order to be sure about these things we will experiment a little: Over my roll-top (?) desk there is a line of $1\frac{5}{16}$ shaft, running 130 revolutions and from which power is taken for a primitive repair shop. There is one 16-foot length that has three bearings, and on it two pulleys, with open and cross belts to a lathe countershaft. I have disconnected this length from the rest of the line and thrown off both of the belts. I will now wind a stout cord around the shaft and see how many pounds weight I must hang on the cord to revolve it. Now, about the conditions of the shaft I will say that it may be round; that it is straight, level and in line, and that the hanger-boxes are loose enough, and well oiled. I find that $53\frac{9}{16}$ pounds will start the shaft, and that the speed will increase until the weight strikes the floor. This length and the countershaft are arranged as shown in the cut, 1, 2 and 3 being the hangers, and *A* and *B* being pulleys for open and cross belts respectively, and *C* the countershaft. Now we will put on the open belt, leaving it on the loose pulley of the countershaft. It now takes $67\frac{11}{16}$ pounds to move the whole. This increase shows the friction of the loose pulley, the extra strain on the shaft bearings, and the friction due to the movement of the belt. We will now take this belt off and put on the cross belt, which goes on a loose pulley like the other. It now takes $69\frac{14}{16}$ pounds to move it, which represents all the other causes, and the additional one of the inner surfaces of the belt rubbing against each other where they cross. I do not know the tension of these belts, but they are just right to do ordinary lathe work. I will now lace them too tight, but not so tight but what they will run all right. The open belt now takes $105\frac{4}{16}$ pounds, instead of $67\frac{11}{16}$, as it did when it was tight enough for practical work, and represents a loss of 55+ per cent., owing to a too tight open belt. Now we will make the cross belt too tight. It now takes $113\frac{11}{16}$ pounds to move it, or a loss of 62+ per cent. for a too tight cross belt. Surely, the fellow that has charge of the belts has something to do about the economy of transmitting power.

Now we will throw off the belts and push the shaft $\frac{1}{4}$ inch out of line, horizontally, by setting over the bearing in adjustable hanger No. 2. It now takes $91\frac{10}{16}$ pounds to move the shaft, instead of $53\frac{9}{16}$ pounds in the first experiment—a loss of 71 per cent.; but this is not so much as it would be if both ends of the shaft were coupled into the line of shafting, for now the ends 1 and 3 are bent back in an opposite direction from what the bearing is moved out of line, and there are but two bends in the shaft, while if the ends were connected to the rest of the line there would be four, the same as in a crank, and the strain necessary to make these four bends is constant while the shaft is revolving. Now we will put the shaft back into line, horizontally, but drop the center hanger $\frac{1}{4}$ inch. This I find to be about the natural sag of this shaft, and it only requires $60\frac{9}{16}$ pounds to move it, which is but 7 pounds more than the first experiment. This I account for from the fact that the shaft assumes this position without artificial force, while in order to hold it the same amount sideways considerable force is required.

All these experiments have referred to the condition or position of the shaft itself; now I will monkey a little with the bearings. A very common kind of hanger is one where the bearing is suspended between two pointed adjusting screws passing through the ends of an inverted ∩-shaped casting that has a vertical adjustment in that part of the hanger that is secured to the floor beams or other supports. Such hangers support the shaft we are at, and I will set up one of these screws a little tighter than it ought to be, but not enough to make it heat. It now takes $70\frac{10}{16}$ pounds to move the shaft, and it goes by jerks, which shows that I have sprung the thin shell of the bearing, and that the shaft is not round; for it will stop once in each revolution, unless assisted to start, at the points where the largest diameter passes the smaller place in the tightened box. Before the box was sprung together, the small amount the shaft lacks of being round had no perceptible effect as it turned, but it was enough out of truth to make itself manifest under the new conditions.

These facts are very suggestive, for they are the result of no untried theory, but data taken from a shaft in actual use every day; and to show that the tightening of the belts and the closing up of the bearing screws was not beyond what may and does frequently occur, I will state that I allowed them to run in this condition for half a day without any trouble except that the loose pulleys heated slightly.

When we take into account the numberless belts and bearings in a large establishment, we can see the possible loss there may be in their care and management. We also saw that some of the things that consumed an unnecessary amount of power could not be helped, owing to the faulty design or poor judgment used when the apparatus was erected, which goes to show that it is just as important that such apparatus for the transmission of power be erected by and in charge of as competent mechanics as any other part of the plant.

Sketches of an Apprenticeship.

BY W. S. ROGERS.

III.

My next effort getting into a shop as a cub was more to my liking. There were parts of engines lying all around, even parts of locomotives, and the owner of the place, after asking my age, and a few family questions, wanted to know how much I knew about geography, grammar, history, and kindred school studies, and how I liked them. Finally he said, "Well, boy, you come to work Monday morning; if there is anything in you we will soon find it out; but bear in mind there is lots to learn and no end to hard work." Quite a difference between my reception here and at the other shop. Not so brilliant a future before me here, but as I walked around through the place noting the enormous sizes (to my eye) of the big planer and boring mill, the neat, convenient tool room, the pattern shop, foundry, and, last of all, the blacksmith shop, with its six roaring fires, a sort of reverence for the man whose energy and knowledge of mechanics had built up such a place came into me, and I was already beginning to feel proud of my prospective apprenticeship, even if it was going to be all hard work.

Monday morning I was on hand early. The foreman asked me if I was the new cub the old man had taken. Replying in the affirmative, he showed me a keg of blank nuts, and showing me how to use a $\frac{3}{8}$ inch tap, he told me to "do them all that way, or better." Well, that job struck me as one of the easiest I ever saw, until the end of the third day, when they rolled two more kegs to me; then I began to get awful tired. Next morning I tried putting two nuts in the vise at once, and sending the tap through both at

once; then I tried three, then four, but found three about the right number, so kept at it that way. During the day the "old man" came round and asked me how I liked tapping nuts. "Don't like it at all," I answered between breaths. "Then why do you tap three at a time?" he asked. "To get rid of the dog'oned old job soon as I can," I said. Then he taught me how to swing the wrench with my shoulders instead of my elbows, and telling me that "plenty of oil, *patience*, and a good tap" would soon finish the job, he left me, but he didn't censure me for doing three at a time in place of one, as I feared he might, neither did he praise my efforts. Why?

He didn't censure, because I was making "two blades of grass grow where one grew before." He didn't flatter me, because I was paid for doing it right. We pay a man to do his work well, but censure him when he fails, and I have noted that the man who is always praising and flattering his workmen is only trying to avoid paying full cash value for his men's labor.

"Taffy" won't buy beefsteak, neither is it good brain food.

The lesson I learned from those three kegs of nuts was to do a job that I did not like as soon as I possibly could, and be done with it. Soldiering machinists don't get very good pay or steady work. They also demoralize the good mechanic, and make him slothful and lazy if permitted to work near him any length of time.

There is a good deal of trouble not only in our navy, but in all the navies of the great nations in the world, in securing men competent to handle the machinery of the vessels. These vessels have come to be repositories of art in the line of mechanical appliances, and it requires mechanics to manage them. A first-class mechanic feels his importance, and has a right to do so as much as any man in the world. He has spent his time just as the so-called professional man has, in mastering the vocation he follows, and it is coming to be seen that—perhaps it is not coming to be seen that he is *entitled* to consideration; it may take some time yet for that—but it is coming to be seen that he will *have* consideration, or modern war-ships will not perform what is expected of them. The idea that he shall receive lower pay and be subjected to the tyranny of every little executive officer will not work well in practice. One place in the world in which the mechanic will demand, and eventually, through much tribulation to the powers that be, receive pay and consideration, is on the modern war-ship. The reason is that these ships cannot be operated successfully without mechanics.

The scarcity of gas continues to play the main part in at least a dozen of the leading iron works. The falling off in supply, and the loss of time, are now so discouraging in some mills that the men threaten to quit work if the change back to coal is not soon made. There are nearly 8,000 iron-workers on both sides of the Monongahela River, who have averaged little more than half time in the last three weeks. In about ten mills the restriction on the output of muck-iron alone is at least 200 tons a day. There are a number of firms now which will commence to prepare for coal to be used in case gas should give out when the weather gets colder. The change is made in the furnaces as they are being repaired from time to time. So far as possible all the mills are run to their utmost, but the average is about two-thirds capacity.—*Pittsburgh Chronicle-Telegraph.*

It is always satisfactory to find that honesty is the best policy. The Germans have just made this discovery in their trade. By the English Merchandise Marks act of 1887, German manufacturers were compelled to be honest, and abstain from pretending that their goods were of British make. They did not like it at first, for they had reared up a big trade under a false mark. But now, from the recent returns of the exports to England, it appears that Germany has been doing better under the system of open dealing than she was before. The great English market in these islands and in our colonies has discovered that there is a certain merit in German goods. They may not be as solid as English goods of the same class, but they are cheaper, and now that their exact character is declared, people who were before shy of the unknown buy them freely for what they are worth.—*Pall Mall Gazette.*

The total number of cotton-mills in the South is said to be 336, with 90,819 looms and 1,819,291 spindles.

Machinists' Supplies and Iron.

NEW YORK, Sept. 13, 1890.

Iron—American Pig—Since our last week's report there has been no change of importance. While in some localities an improvement in demand is noticed, the general condition of the trade is about the same as it has been for some time past. Contract deliveries continue to absorb the output of the leading brands pretty closely, and consumers make new purchases only to cover current wants. Prices are firmly maintained on all leading brands.

We quote Northern No. 1 Foundry, $17 to $18; No. 2, $16 to $17; Grey Forge, $15 to $15.25; Southern No. 1, $16.50 to $17.25; No. 1, Soft, $16.50 to $16.75; and No. 2, $15.75 to $16.

Scotch Pig—The demand has continued moderate, only small lots changing hands.

We quote Eglinton, $19.25 to $19.75; Dalmellington, $21 to $21.50; Coltness, $23.50 to $24.

Bar—The demand has been moderately good, and prices are without quotable change.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—No quotable change has taken place in values here, though prices have advanced somewhat in London, owing to speculative operations. Lake can be had at 17c.; common casting brands, 14½c., and Arizona, 15¼c.

Lead—The market has ruled dull, but firm, consumers and dealers showing no disposition to buy beyond current wants, but sellers remain firm as to prices. Values range from 4.80c. to 4.90c.

Spelter—The demand for Western has been moderate, but the offerings have been light, and the market has ruled steady.

We quote ordinary brands, Western, 5.50c. to 5.60c.; choice, 5.70c. to 5.75c.; refined, 6.75c. to 7c.; Silesian, 7c. to 7.50c.

Tin—The market in London has ruled firm and still higher, but values are so far about the same on this side. For spot deliveries we quote 22⅜c. to 22¾c.

Antimony—The demand for Regulus has been moderate, and prices are without notable change.

We quote: Hallett's, 19⅞c. to 20c.; L. X., 21¾c.; Cookson's, 22¾c.

Lard Oil—The demand continues good, and prices are maintained at 52c. to 52½c.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Mechanical draftsman wants a situation. O. N., care of AMERICAN MACHINIST.

Wanted—Position as engineer; thoroughly competent, sober and reliable. BOX 71, AM. MACH.

Wanted—Position by mechanical draftsman; references. Address 19 Townley st., Hartford, Conn.

Practical machine shop foreman desires change. Address BOX 74, AMERICAN MACHINIST.

Wanted Immediately—Foreman for car-works machine shop; state age, exp., ref's, and salary wanted. Address Car-works, care AM. MACHINIST.

Wanted—Experienced draftsman, with large company in Pennsylvania, building engines and rolling-mill machinery. BOX 72, AM. MACHINIST.

Wanted—At once, two first-class machinists; steady, sober men can find work at good wages. Bluefield Iron Works, Bluefield, W. Va.

Wanted—A position as superintendent or foreman of boiler shop, practical boiler maker; best references. Address Wm. C. Miller, S. Chicago, Ill.

A draftsman and mechanical engineer wants the designing of light machinery and tools for manufacturing to do. BOX 75. AMERICAN MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Wanted—Two good metal pattern makers, on iron pipe fittings and brass valves. Address, stating wages and experience, The Kelly & Jones Co., Greensburg, Pa.

Wanted immediately: One good designer and draftsman of practical exp. on metal-working machinery; also planer man, and two good scrapers and filers; we will give steady work to competent men. Fitchburg Machine Works, Fitchburg, Mass.

Wanted—One good brass molder to take charge of brass foundry; one who understands mixing; only first-class men need apply; good salary and steady employment guaranteed. Address The Hawkeye Electric Mfg Co., Davenport, Iowa.

Exp'd mech. draftsmen wanted immediately; those having experience with electrical apparatus preferred; permanency to good men. E. Kolben, Edison Gen. Elec. Co., Schenectady Works, Schenectady, N Y.

Wanted—A good gear cutter wishes to change; is familiar with Gould & Eberhardt and all other machines. Any one in want of such a man will do well to address Thomas F. Herrick, Husted Court, Providence, R. I.

Wanted—Good machinists, boiler makers and molders; first-class workmen can obtain steady work and good wages; shops large, convenient; living cheap; four other large shops and foundries. Watertown Steam Engine Co., Watertown, N. Y.

A college-educated draftsman, with experience in designing and building automatic compound steam engines, vertical and horizontal, can find employment with a large engineering establishment in Pennsylvania. Address Box 73, AM. MACHINIST.

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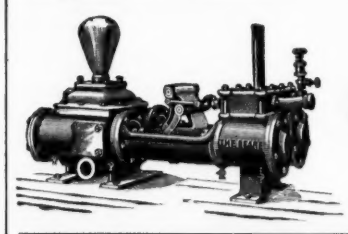

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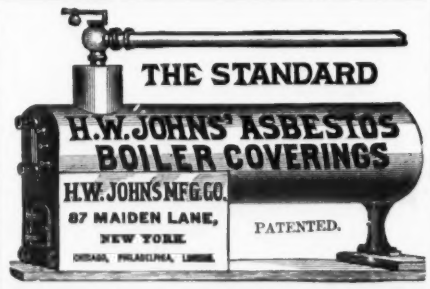

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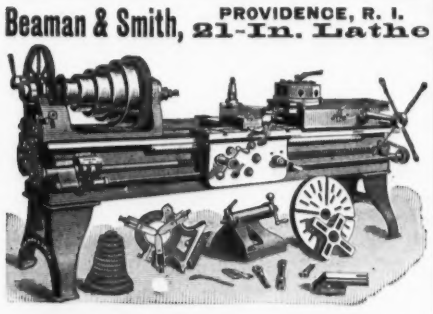

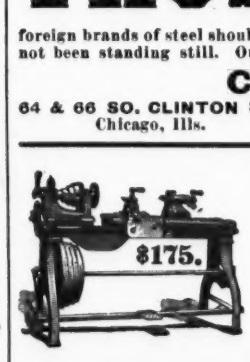

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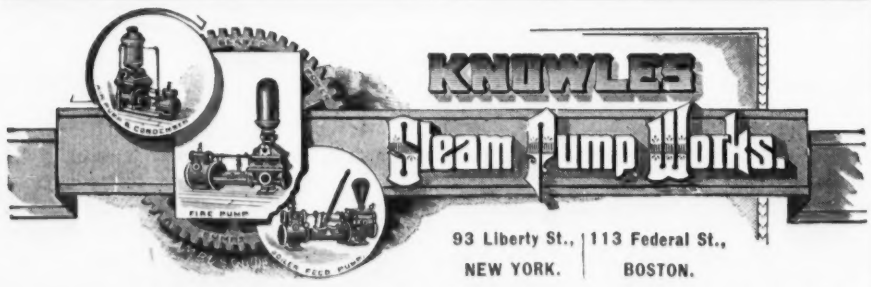

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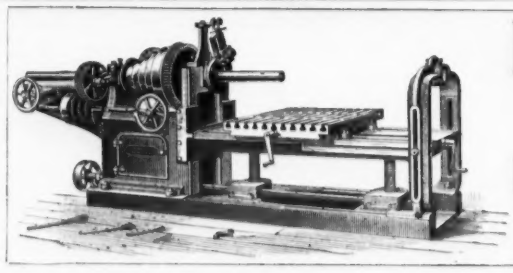

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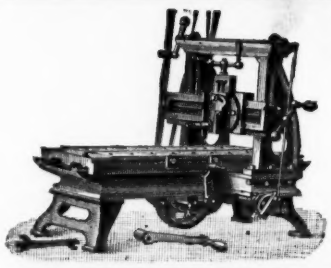

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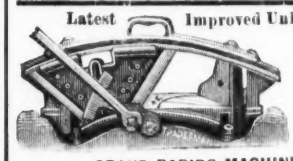

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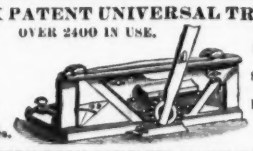

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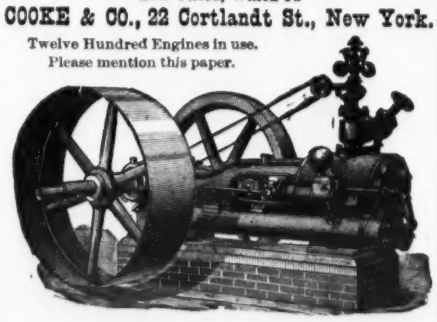

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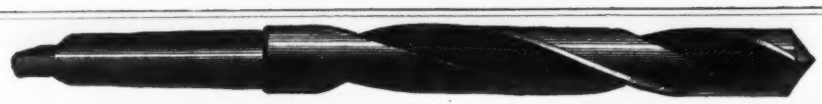

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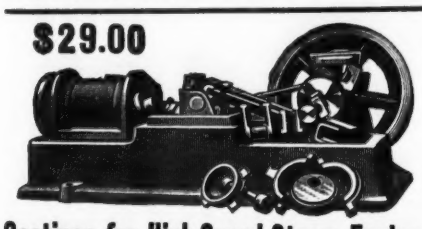

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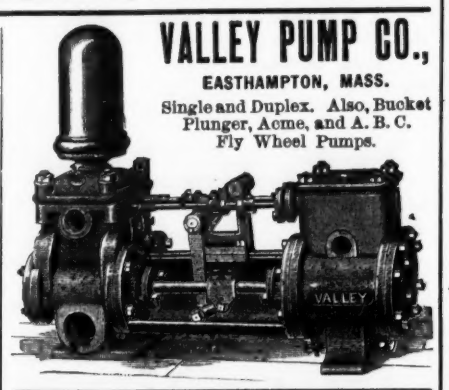

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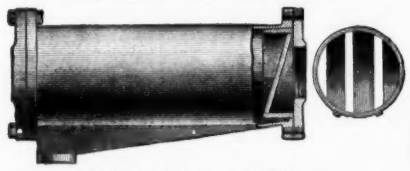

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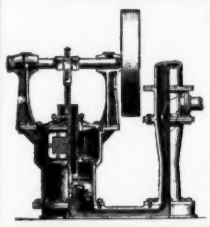

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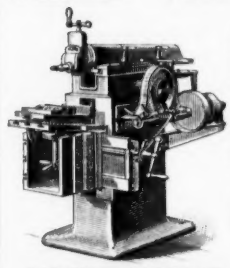

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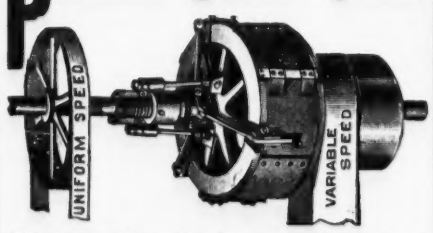

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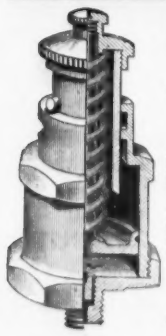

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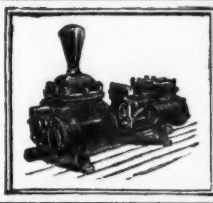

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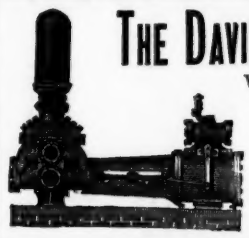

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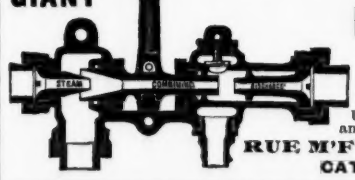

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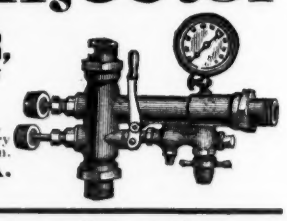

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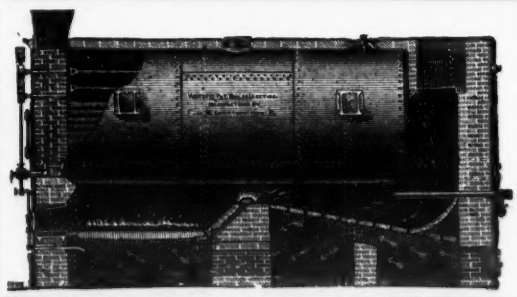

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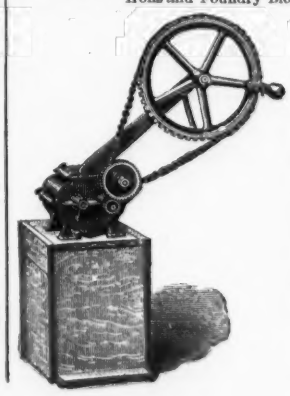

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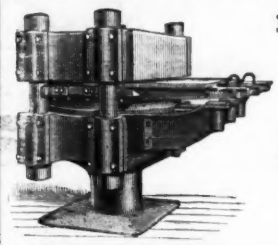

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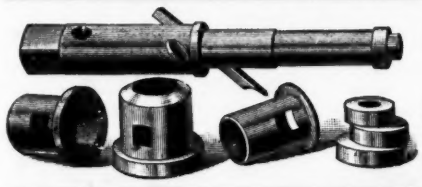

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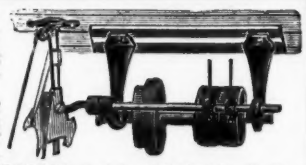

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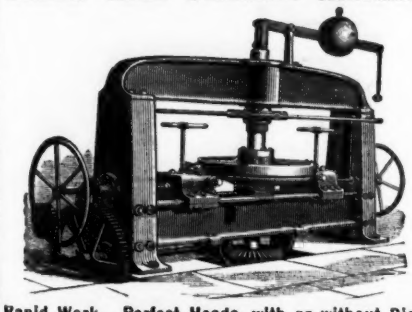

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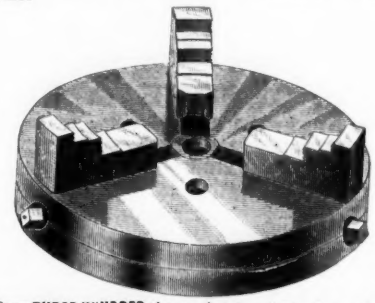

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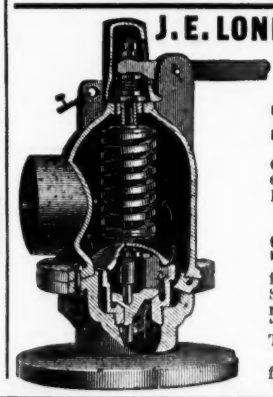

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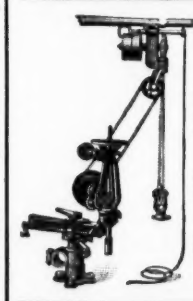

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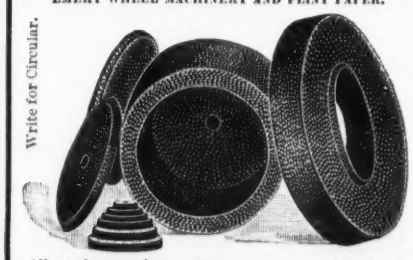

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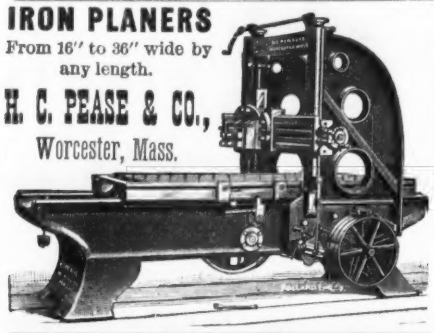

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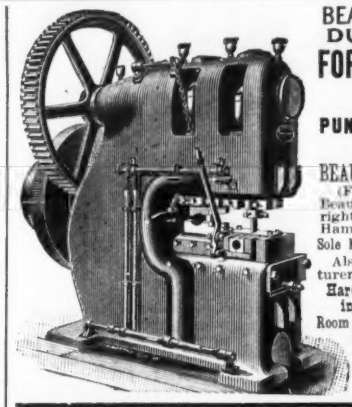

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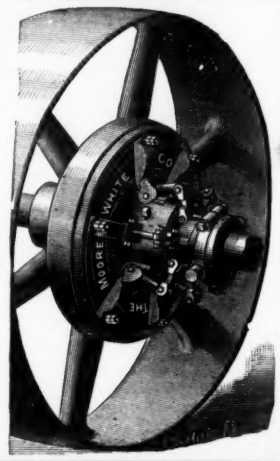

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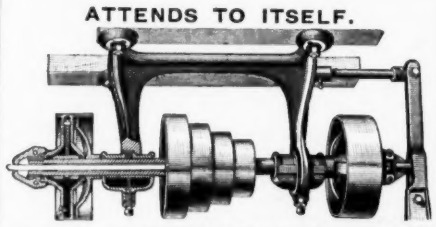

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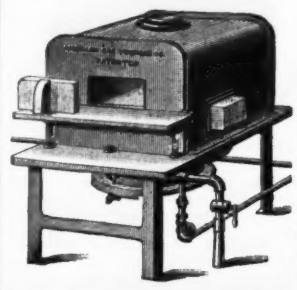

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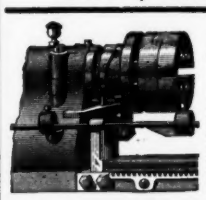

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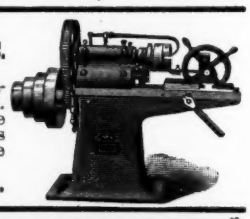

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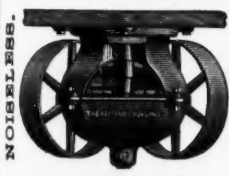

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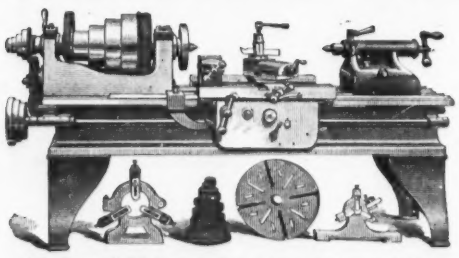

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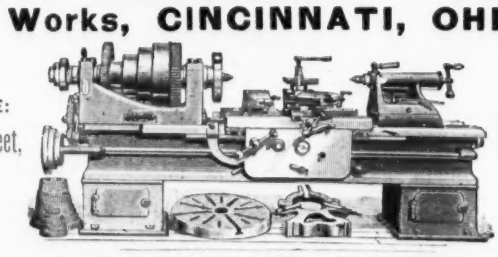

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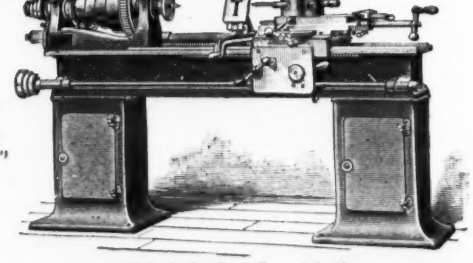

18-inch Cabinet Turret Lathe.
Taper Attachment, Automatic Feed, Lever and Screw Movement, most complete brass lathe on the market.

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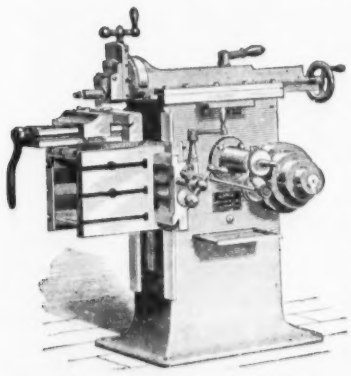

15 and 20-inch Crank Shaper.
Stroke changed and adjusted while running. Stroke at all times positive. Invariably plane to a line. Detachable Tables.

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IRON PLANERS
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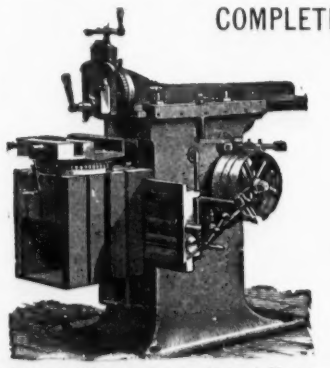
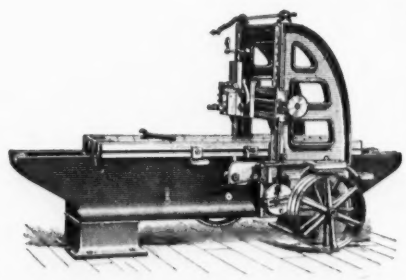


20, 26 and 32-inch Triple Geared Shapers.
Stroke changed while machine is running. Shaft can be passed through head of machine and key seat cut in same to any length. Extra heavy vises. Tables slotted on all sides.



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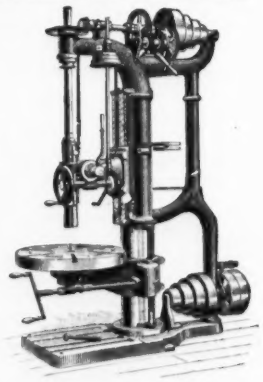

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Automatic stop to feed. Quick return on right side. Table operated from front. Large cones and long belts.

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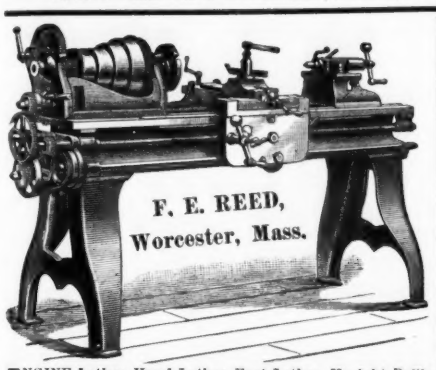

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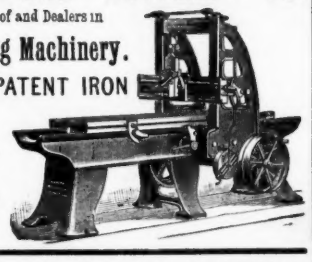

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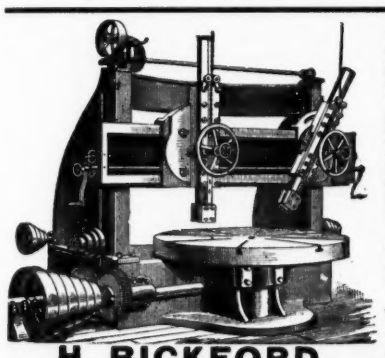

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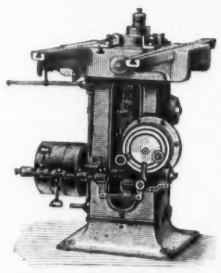

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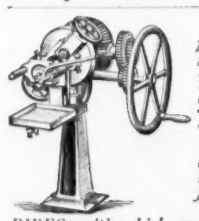

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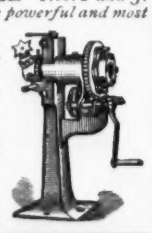

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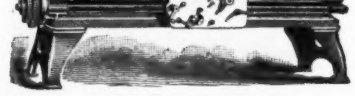

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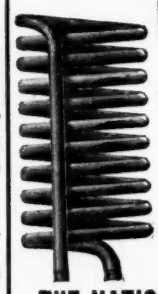

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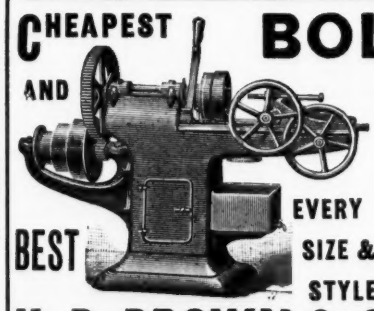

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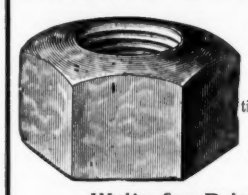

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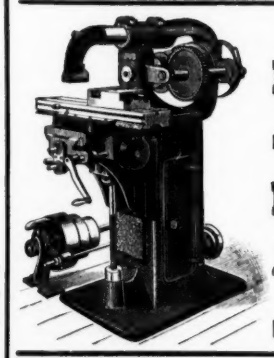

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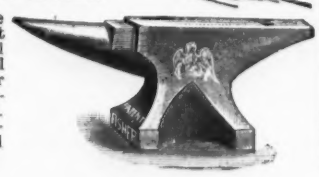

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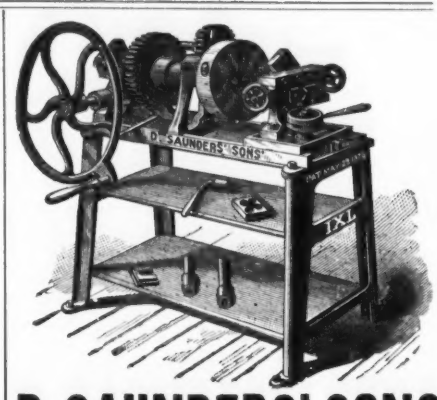

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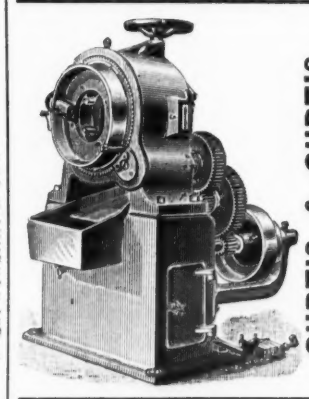

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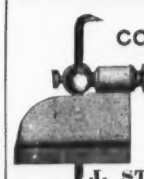

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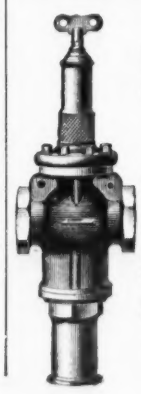

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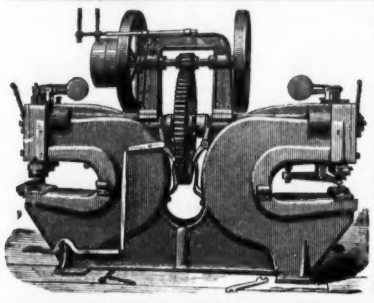
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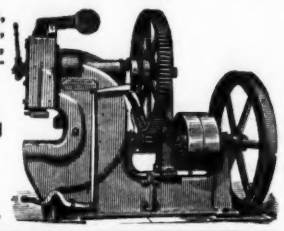

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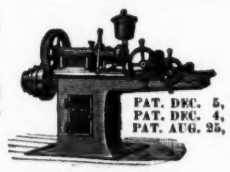

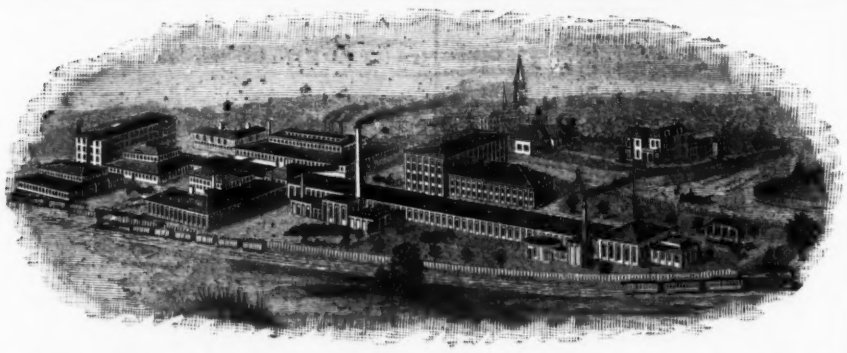
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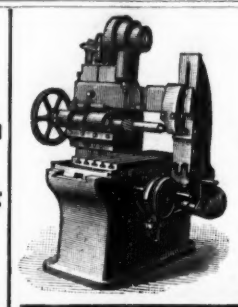
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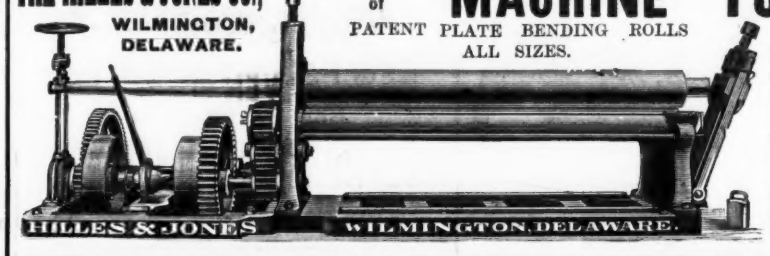

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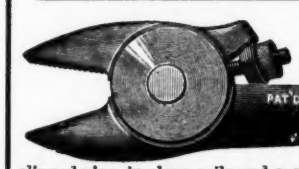
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



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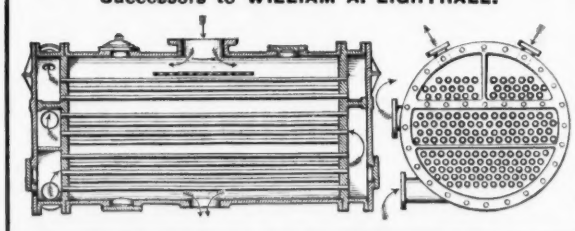
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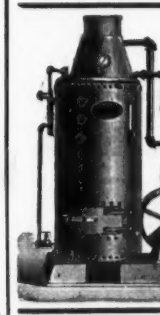
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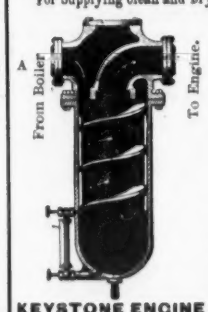

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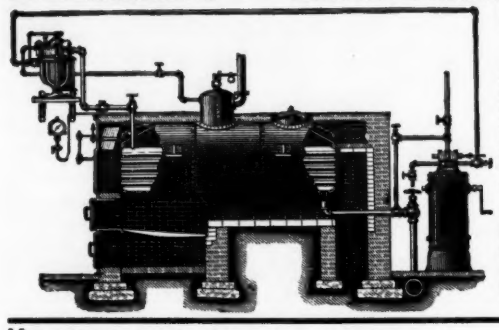

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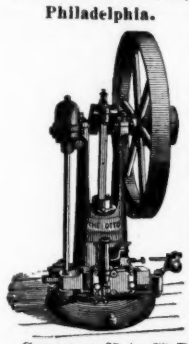

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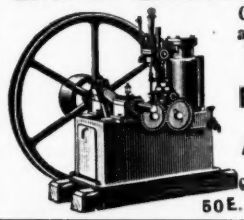

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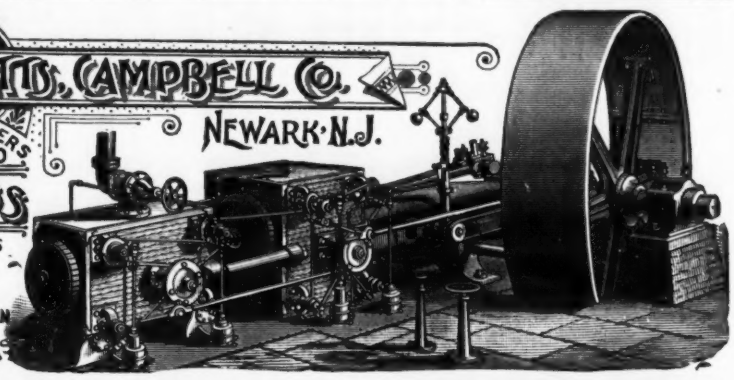

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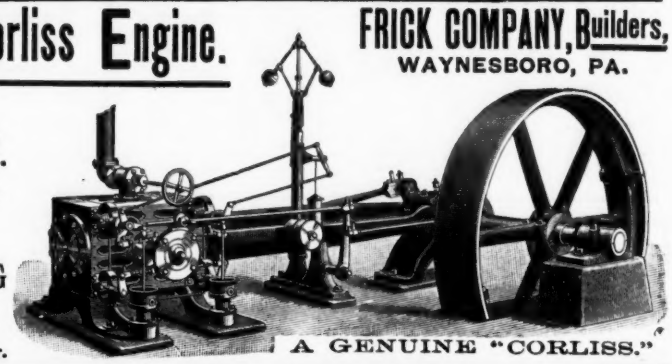

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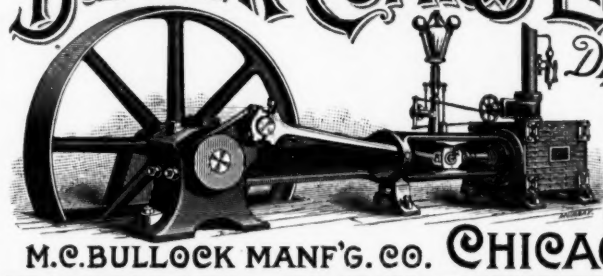

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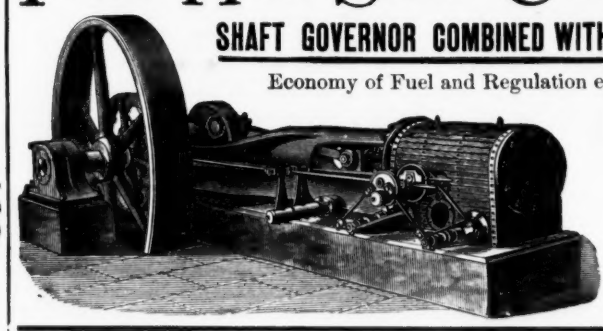

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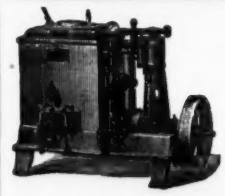

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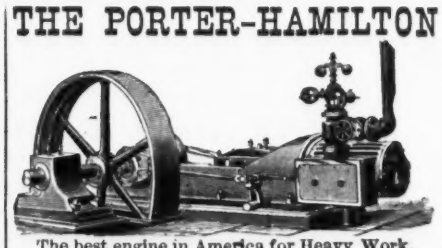

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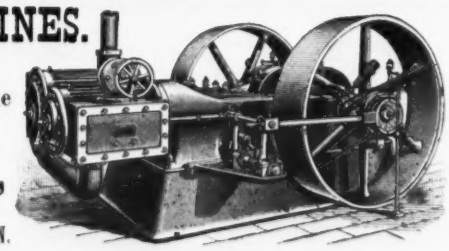

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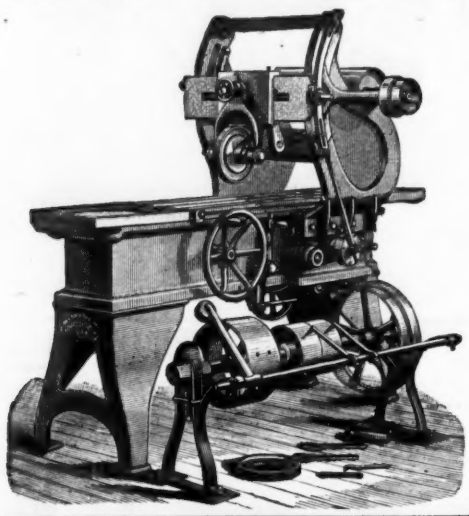

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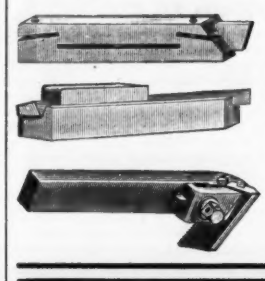

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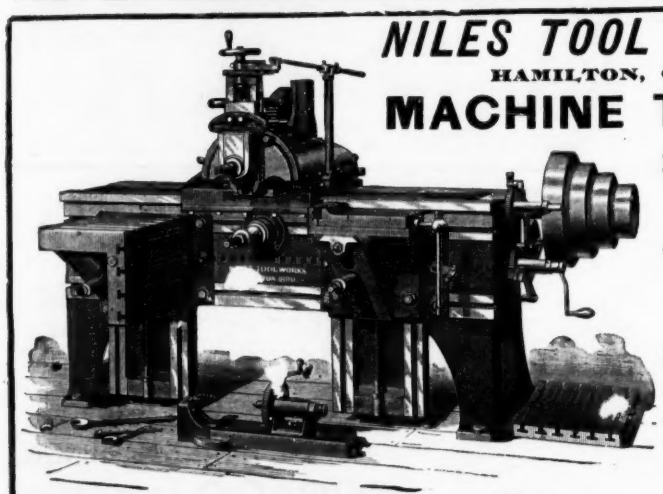

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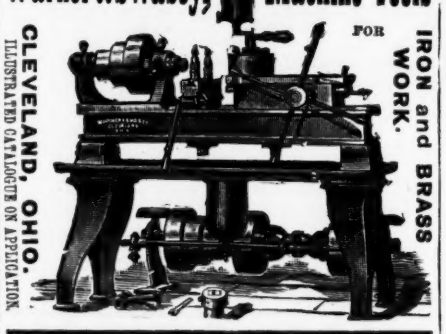

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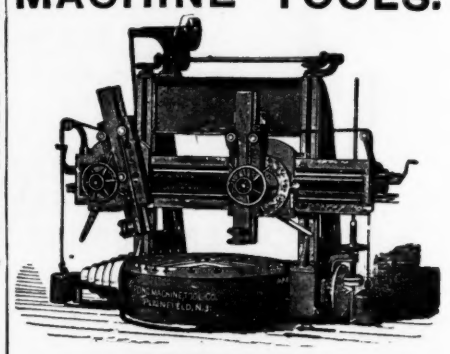

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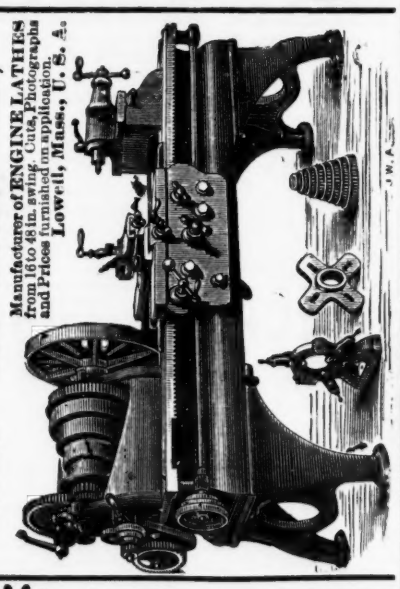

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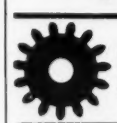

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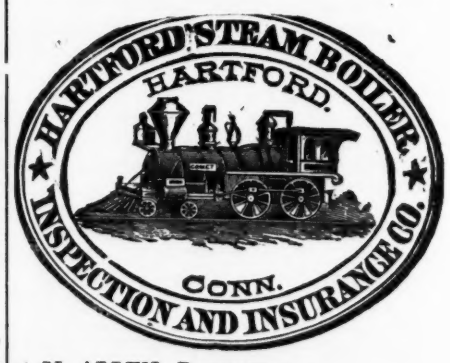

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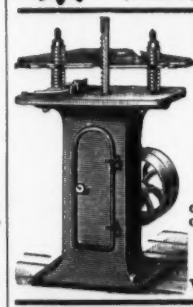
New York Store, 64 Cortlandt St., New York.

14″x 6′ Engine Lathe,	14″x5′ Plain Fox Monitor Lathe,	26″ Geared Shaper.
15″x 6′ " "	14″x5′ B. G. " "	20″ W. & L. National Drill,
18″x 8′ " "	15″x6′ " " " "	30″ S. H. Standard "
18″x 8′ Imperial Engine Lathe,	18″x6′ Cabinet Turret Lathe,	24″ " " "
18″x12′ Standard " "	16″ Pattern Makers' Lathe,	24″ B. G. P. F. National "
19″x11′ " " "	16″ Wood Turners' "	28″ " " "
19″x13′ " " "	12″x4′ Hand Lathe,	32″ " " "
21″x 8′ Imperial " "	15″x5′ " "	28″ Standard B. G. P. F. "
12″x 4′ Turret Lathe,	20″ Crank Shaper,	32″ " Standard "
15″x5′ Turret Lathe,	20″ Geared Shaper,	B. G. Milling Machines.
18″x6′ Automatic Turret Lathe,		

Our Stock is constantly changing. Write for full particulars and prices. Outfits a specialty.

THE LODGE & DAVIS MACHINE TOOL CO.,
Manufacturers of and Dealers in Iron and Brass Working Machinery,
64 CORTLANDT ST., NEW YORK.
WORKS: Cincinnati, Ohio. WESTERN HOUSE: Chicago, Ill.

Key-Seating Machines and 20 in. Drills



A SPECIALTY.
SEND FOR LIST OF
New and Second-Hand
Lathes, Planers, Drills, or anything in Machinists' Tools or Supplies.
W. P. DAVIS,
Rochester, N. Y.
Works at North Bloomfield.

Send for circulars describing our
NEW STYLE SPIRAL-GEARED PLANERS,
3 ft., 4 ft. and 5 ft. square.
ALSO OUR "ORIGINAL" LINE
24″, 26″, 30″, 32″, 36″, 42″, 48″, 56″, 62″.
THE G. A. GRAY CO.,
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GOULD & EBERHARDT,
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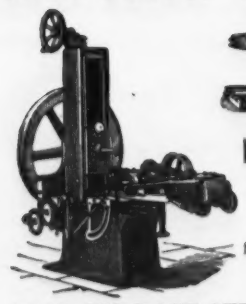
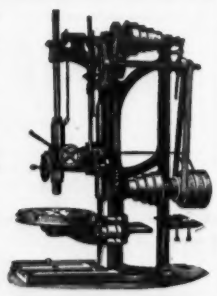
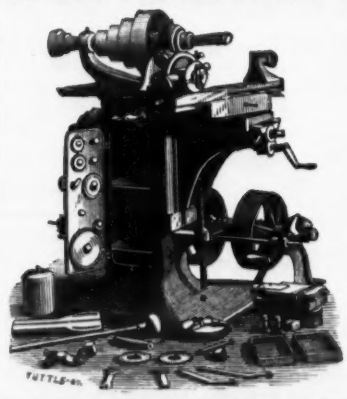
EBERHARDT'S PATENT
DRILL PRESS.





EBERHARDT'S Patent GEAR CUTTER.
Sizes, 18″, 25″, 36″, 50″, 60″, 84″.
GEAR AND RACK CUTTING TO ORDER.

THE GARVIN MACHINE CO.,



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Gear and Rack Cutting, Milling and Index Drilling to Order.

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PRATT & LETCHWORTH,
PROPRIETORS
BUFFALO STEEL FOUNDRY,
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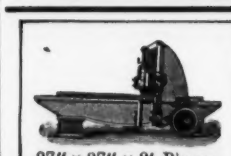
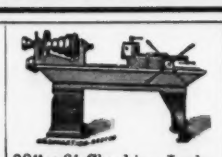
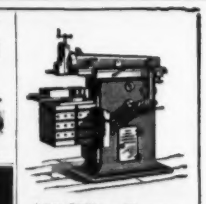


27″ × 27″ × 8′ Planer.



20″ × 6′ Chucking Lathe.

16″ × 6′ Engine Lathe.



25″ Pillar Shaper.

THE HENDEY MACHINE CO. TORRINGTON, CONN.
MANUFACTURERS OF MACHINE TOOLS. SEND FOR OUR CATALOGUE.

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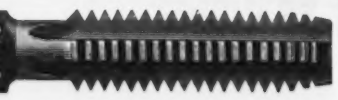

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